SIGNAL

August 1960

"... it is evident that any serious fluctuations in defense's support of electronics engineering work will have repercussions throughout the entire profession."

See page 6

"the technique that was used in the preliminary design of Tiros was that of a Brownie camera."

See page 22

"it is no longer sufficient . . . merely to stand ready to satisfy military requirements."

See page 31

COMMUNICATIONS ■ ELECTRONICS ■ PHOTOGRAPHY

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Total Device Dissipation at 25° C . . 35 mw			
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Collector Voltage, V_{CE} ($I_C = -2$ ma, $I_B = -0.2$ ma)		.095	.13 V
Gain-bandwidth Product, f_T ($V_{CE} = 1$ v, $I_C = 1$ ma)	125	175	mcs

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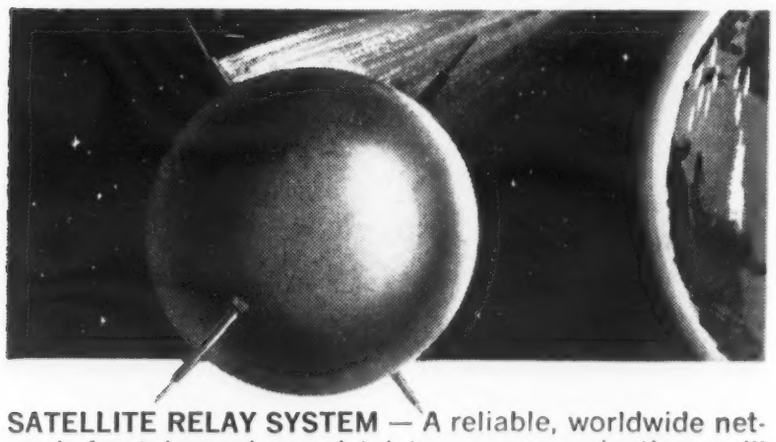

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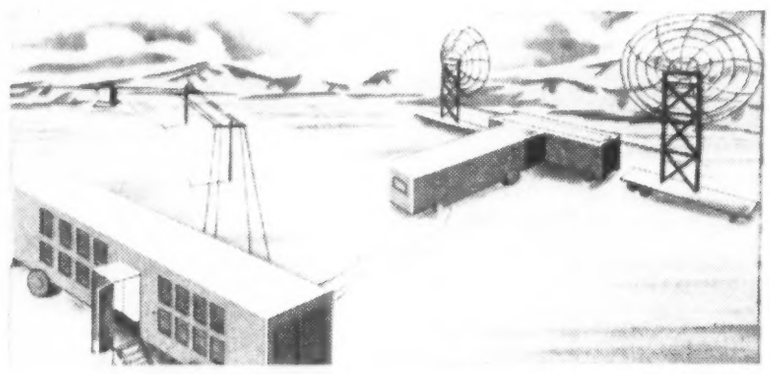

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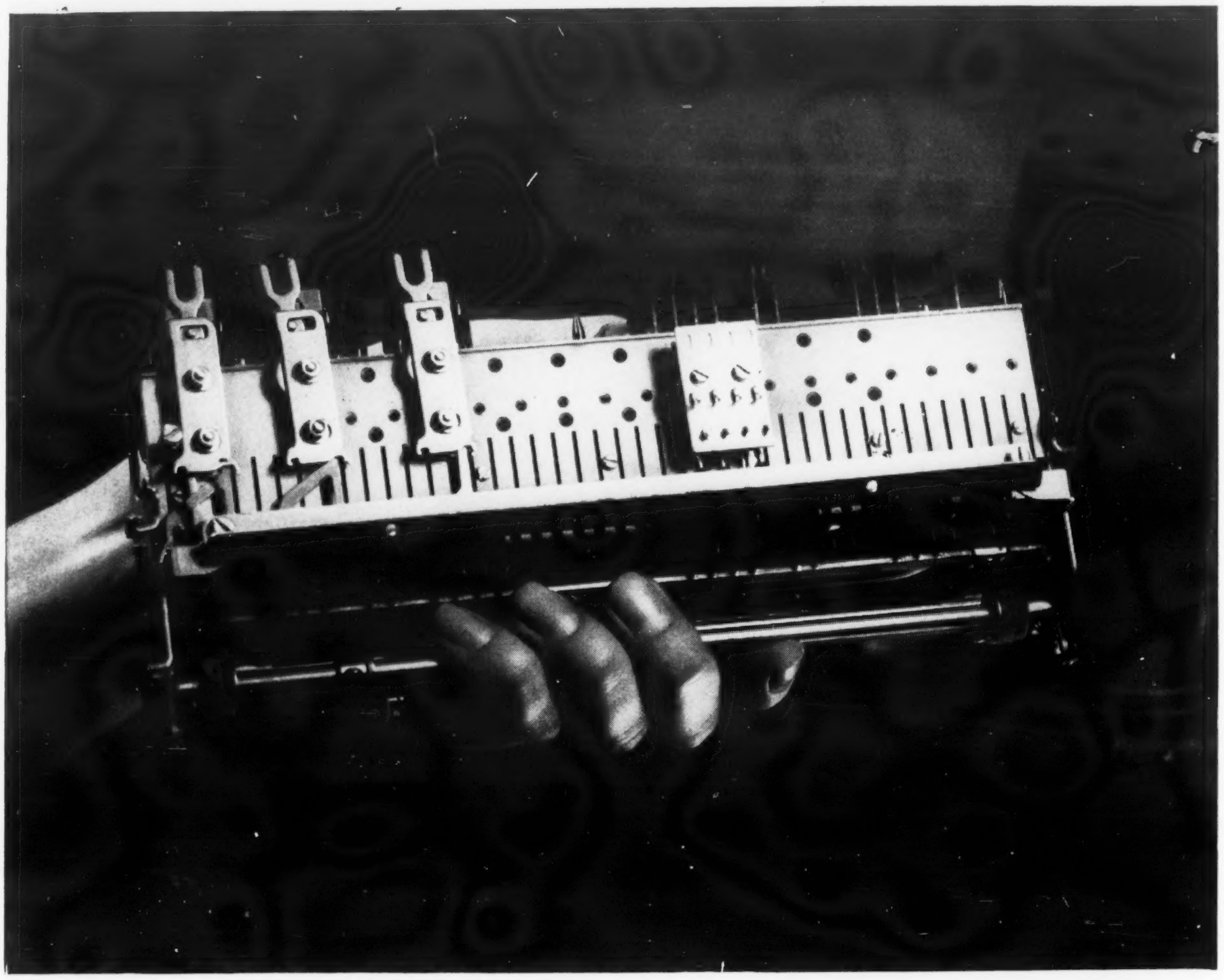

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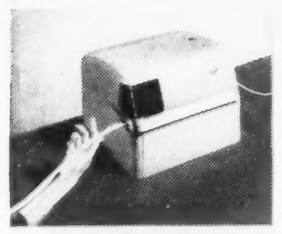

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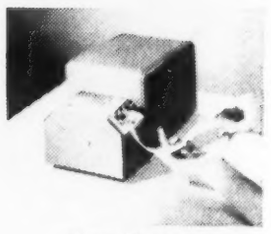

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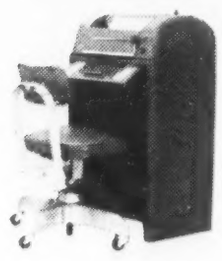

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SIGNAL

Communications-Electronics-Photography

Journal of the Armed Forces Communications and Electronics Association

VOLUME XIV AUGUST 1960 NUMBER 12

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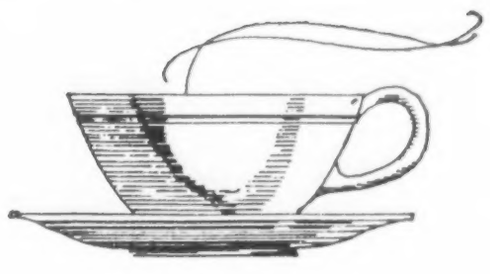

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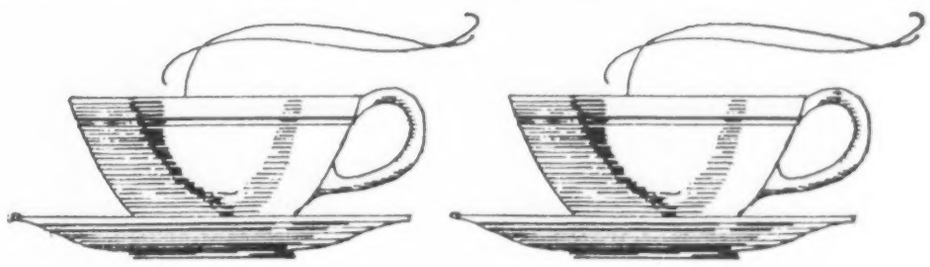

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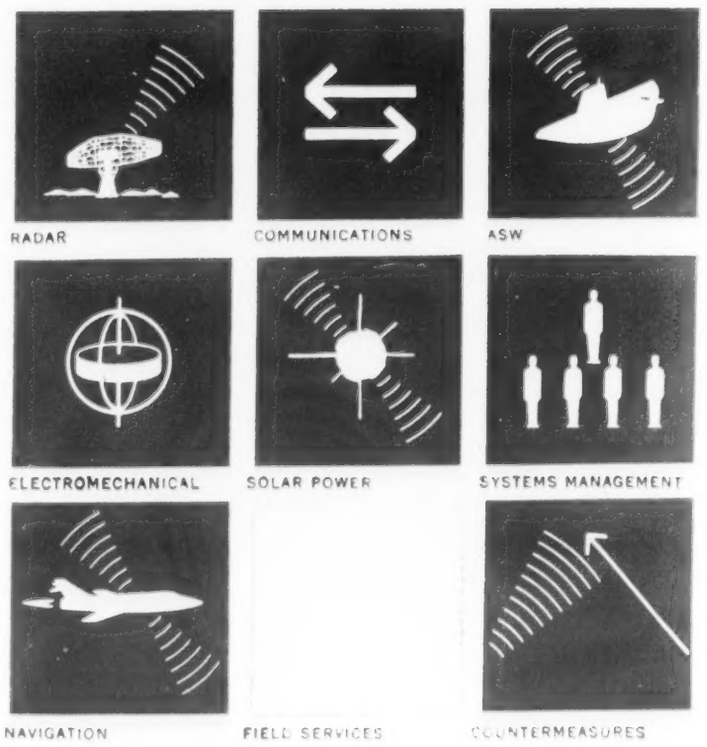

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DEFENSE ELECTRONICS AND

the engineer

by JAMES M. BRIDGES

Director, Office of Electronics, Office of the Director of Defense Research and Engineering

AFCEA CONTRIBUTES very significantly to national defense by fostering healthy industry-military relationships and by developing a broad mutual understanding of the many complex technological and management problems associated with the rapidly advancing field of military communications-electronics.

Rather than attempt to cover the many technological advances that have exerted a direct influence on military electronics, I have chosen to discuss some of the significant changes taking place in our over-all defense planning and will attempt to interpret these changes in terms of their meaning to defense electronics.

During the next decade, man will make his first venture into space; the secrets of the universe will be unfolded at a continually increasing speed; the application of a rapidly expanding technology will improve the living conditions and prosperity of all men throughout the world. Yet, we are entering this period in the face of a growing threat of weapon forces that could completely destroy civilization in a few hours.

It is possible that within only a few years the world may face a deadly weapons stalemate in which the continued existence of civilization can depend upon the actions, decisions and diplomacy of a few men in high government positions. It will be a situation in which limited wars can flourish and perhaps become fairly important conflicts without starting a thermonuclear exchange between the Soviet Union and the Western World.

Once established it is doubtful that this weapons stalemate will be significantly unbalanced in the near future by antimissile defenses. It appears that, for the first time in history, the technological and economic gap between offense and defense has become so wide that bridging it is unlikely without a revolutionary advance in defensive-weapon capabilities comparable to that of the thermonuclear weapon itself. Furthermore, it is not clear to me that any decisive military advantage would be gained by either nation developing offensive space weapons, even though the psychological effects of fear and the national prestige associated with leadership in space technology could have an important bearing upon the world political position.

This weapons stalemate, which Vice President Nixon has so appropriately called the "balance of terror," has a controlling influence on total defense planning and during the past year has brought about the reorientation of many major programs. Let me mention briefly the program redirections that appear to have the most significant effect upon defense electronics programs and plans.

(1) Emphasis has been increased on programs associated directly with improving and maintaining the effectiveness of our current manned-bomber striking forces and expediting the readiness of intermediate-range and intercontinental ballistic missiles.

(2) A firmer policy is developing with regard to the relative position of missiles and manned aircraft as future elements of the strategic striking force.

(3) Effort is being substantially reduced on the development, production and weapon-deployment programs aimed at long-range improvements of continental air defense against manned-bomber attack, and the initiation of major research and development programs in this area is doubtful. This does not mean that we are dropping our guard against a possible attack by manned aircraft. Our present air defense capability is good and when improvements now being made are completed, our continental air defense system will be entirely adequate to cope with the bomber threat.

(4) Early warning against ballistic-missile attack is being heavily emphasized. Even in a situation of "destructive missile saturation," there would be some advantage in having maximum warning that a missile attack has been launched. Such warning is, of course, extremely important during the next few years when our primary strategic force consists of manned bombers. A major program in the ballistic-missile early warning area is the BMEWS. Research and development work is also proceeding on over-the-horizon radar, infrared and other techniques for obtaining warning of missile firings early in their initial flight through the atmosphere. Satellite systems for this application are also under development.

(5) More emphasis is being given to research and

development programs aimed at increasing the capability and reliability of global communications and command control systems. Because of the demand for greater speed and capacity of communications, as well as a higher degree of reliability, the new communication and command control systems will rely heavily on automatic switching and electronic computers. Research and development is continuously proceeding on the use of satellites as a communication medium.

(6) Because the availability of an effective defense against attack by ballistic missiles would produce a significant imbalance in a weapons stalemate, high-priority effort is continuing on research and development in this area. This includes exploratory research in areas of radically new weapons technology.

(7) Emphasis is increasing on research and development leading toward improved capabilities to conduct limited or tactical warfare. Better surveillance, greater mobility, decreased weight and volume and improved reliability and flexibility of weapons and equipment are among the main objectives of this research and development effort.

Implications on Industry

While these and other changes in defense planning are well known throughout the defense industry, I doubt that their true implications on the electronics industry —and particularly upon the electronics engineering profession—are fully recognized. I don't thoroughly understand the full significance of the problem; but I am convinced that it is so important to electronics engineers and management people that it deserves immediate study by industry, by the Department of Defense and by all industrial and professional organizations associated with electronics. I would like to present the problem as I see it and to urge all of you in AFCEA and in defense electronics to look at it carefully.

For a proper understanding of the situation, we must first recognize how critically our total national electronics engineering resources depend on Defense. I expect that, since it is known that the total defense expenditures in electronics represent about one-half of the total output of the electronics industry, it may be the general belief that about one-half of the electronics engineering people are employed on Defense work. This is not so. The best information available to my office indicates that between 80 and 90 percent of our national electronics engineering resources are being supported by Defense. Thus, it is quite evident that any serious fluctuations in Defense's support of electronics engineering work will have repercussions throughout the entire profession.

Reduction of Engineering Effort

Let us go back now to the Defense program reorientation I outlined a few minutes ago and consider what effect it may have upon the electronics engineering work load. It seems obvious that, during the next year or so, there will be a substantial reduction in the engineering effort going into continental air defense against manned aircraft. This includes all types of interceptor-aircraft electronics, airborne early warning, surface-to-air and air-to-air guided missiles, data links, ground radars, identification devices, data-processing equipment and many other associated system elements. Likewise it appears that future engineering effort in manned-bomber electronics will be drastically reduced. Also, many component and technical developments specifically applicable to these areas will be affected.

Taken together, these areas of electronic engineering have employed a substantial percentage of all of the electronics technical people working on Defense programs in the past several years. At present we have no accurate account of the actual numbers involved, but we believe it may be as much as 40 to 50 percent. It is quite evident that a major reduction of engineering effort involving so large a segment of our electronics engineering resources is going to present a serious management problem to Defense and the electronics industry.

It is true that, as the demands for engineers in this area of Defense decrease, there will be an increasing demand in other areas, such as space, ballistic missiles, ballistic-missile defense, tactical warfare, communications and antisubmarine defenses. However, I do not believe that these expanding areas will, in themselves, warrant the continued effective employment of the electronics engineers now engaged in Defense work.

Reassignment of Engineers

Several large Defense electronics programs have been canceled in recent years. This has not caused any serious dislocation of engineers, primarily because the people released were almost immediately reassigned to other Defense projects in the same companies, usually without the addition of new projects. As a result, the total annual costs of electronics engineering to the Department of Defense have not been lessened by these program cancellations; but we have paid more for the engineering work where this engineering "padding" has taken place —often in cost overruns on cost-plus-fixed-fee contracts. This is one of the reasons that the cost of military electronic engineering work has increased so rapidly during the past few years, far faster than increases in wage and material costs. It has also been a major factor contributing to "mass engineering," which I defined in a talk at Syracuse in November 1956, as "an expression used to describe a situation where several engineers are assigned to a job which could be adequately accomplished in the same length of time by one competent engineer properly supported by technicians."

Defense has accepted these practices in the past because the program fluctuations have not represented a large percentage of total effort. I doubt very much, though, that the government can or should condone this absorption process as the demand for engineers on air-defense and manned-bomber electronics programs decreases, because too large a percentage of our total engineering resources is involved.

As I stated before, a certain readjustment can be made by sensibly planning and directing the reassignment of work and people in other areas of military electronics engineering work. But I am confident that this will not result in productive employment for 80 to 90 percent of the nation's electronic engineering resources over the next several years.

This would indicate that I believe there may be considerable unemployment in the electronics engineering profession in the future. As a matter of fact, there is a very real chance that this can happen unless we soon take very definite steps on a national basis to prevent it. I will admit that it is surprising—and perhaps unbelievable—to even suggest such a possibility in an era when we have been hearing so much about the serious shortage of engineers in this country.

Obviously we must not permit any appreciable unemployment of electronic engineers. It is essential to the health of the electronics engineering profession and the nation's future security and economic growth that every competent electronics engineer in the United States be

(*Continued on page 42*)

communications-electronics

in the deep freeze

1

ANTARCTIC COMMUNICATIONS

Chief Warrant Officer Donald Cree, USN
Staff Electronic Officer
U. S. Naval Support Force Antarctica

2

TRY TO PICTURE YOURSELF stationed in a land where the simple pleasantry of ordinary sunshine is an event that calls for the most hilarious of celebrations. Imagine stepping out of the Communications Building for a breath of fresh air and feeling ice form on your face and beard from your own breath—because the outside temperature has dropped to 50 degrees below zero.

Commonplace objects like rubber tires and even steel wrenches become brittle and snap like kindling. The wind lashes at camp sites with velocities in excess of 100 knots. It blows snow, sand and gravel with such force that it strips the paint from vehicles, pulverizes window glass and buries entire buildings. These phenomena are commonplace. To make the ominousness complete, they take place in the shadow of an active volcano.

This is the story of Antarctic Communications and the men who run them.

Operation Deep Freeze I, during 1955 and 1956, gave birth to the Antarctic Communication System. With RAdm. George J. Dufek, USN (Ret), commanding the first Deep Freeze, the U. S. Naval Support Force, Antarctica (Task Force 43), brought several thousand men to Antarctica to establish scientific research stations at seven remote locations. The stations were to provide housing, messing and working facilities for the many scientists engaged in the various phases of antarctic research during the International Geophysical Year (IGY).

All bases were built in record time. Newly adopted methods of prefabrication that were developed during the years following World War II were utilized. Manpower and special engineering skills were provided by men from the Construction Battalion of the U. S. Atlantic Fleet. Their resourcefulness and ability to adapt to the most trying situations proved the aptness of their motto, "Can do!"

To aid the scientists in their projects, a complex communication network was established. Technical information obtained from their experiments and exploration was passed to the other stations and back to the literally dozens of interested agencies in the continental United States. Weather information was relayed to all stations in the interest of flight safety. Information of public interest, such as new releases and personal interviews, was channeled to news agencies and radio stations that had representatives on the scene. Administrative traffic concerning logistic,

medical and personnel matters was relayed by Task Force 43 to all interested activities. This communications system was designed to be capable of handling its traffic regardless of the challenge of the climate.

All stations were originally linked with low-powered transmitters. Most of the traffic was passed by continuous wave. Early attempts to use facsimile failed. Homer-type equipment was almost nonexistent, the only available units being of very low power. Only one station, that located at NAF McMurdo, had transmitters capable of 1 kw output.

It soon became apparent, due to communication "blackouts," equipment breakdowns, and the increasing volume of traffic, that more expeditious means of transmission and message handling were necessary. Under the guidance of qualified electronics personnel, and with the assistance of the Ground Electronics Division of the Bureau of Ships, several bases were soon equipped with frequency shift key and radio-teletypewriter equipment. Additional transmitters with a capability of 3 kw were installed. Newer and more up-to-date test equipment was shipped to the stations. The original antenna fields underwent radical modification. Doublet and long-wire antennas were replaced by higher and longer three-wire curtain-type rhombics. Vertical whips were replaced by the newer, more efficient sleeve-type antennas.

Installation of antenna fields in the antarctic has always been a major problem. The presence of perma-frost requires that special boring tools be used for digging guy wire anchor holes. Explosives are frequently necessary to obtain adequate penetration. Mounting plates for the base antenna towers must be of the "sandwich" type. Two metal plates are laminated on both sides with material that impedes heat conduction. This base keeps the perma-frost below the plate from thawing during the brief summer, thus preventing settling of the antenna. Transmission lines are of the open wire type with impedance about 600 ohms, and elevated from ten to fifteen feet above the ground to permit traffic to pass. All transmission lines use either No. 6 copperweld or hard drawn copper. These materials can tolerate the ravaging effects of antarctic windstorms.

One of the more important commodities of each antarctic base is electricity. Each station has its own diesel-powered motor generators to provide electric power for cooking, lighting, electrical and electronic equipment. However, the supply of diesel fuel has often become critically low at some of the stations, necessitating stringent use of electrical equipment until the next resupply period.

Logistic Problem

The inland bases can be resupplied only during the antarctic summer, October to January. This is a logistic problem that severely limits the type of transmitters that can be installed at the bases. At present, the main communication station of NAF McMurdo has two transmitters capable of 3 kw operation. Other stations are limited to a power output of either 500 or 1000 watts, depending on the type of equipment installed. It is anticipated that in the near future newer and more efficient equipment will be installed that will enable all stations to further increase their radiated power.

The snow in Antarctica is unlike that found in any other part of the world. It is extremely fine, very dry and powdery. It penetrates even the most minute crevasses. The camp originally constructed at Byrd Station is now completely buried under snow. It is estimated that the tops of the original antennas built only four years ago are now under about 15 feet of hard, packed snow. Because the air is consistently extremely cold, the snow contains almost no moisture. Radiation patterns that were taken recently were compared with patterns made when antennas were suspended above the snow level: they do not indicate any appreciable loss in radiated power caused by the effects of complete burial under snow. This oddity is a subject of much controversy. It may prove to be an important factor to consider in the design of future antennas for climatic areas like Antarctica.

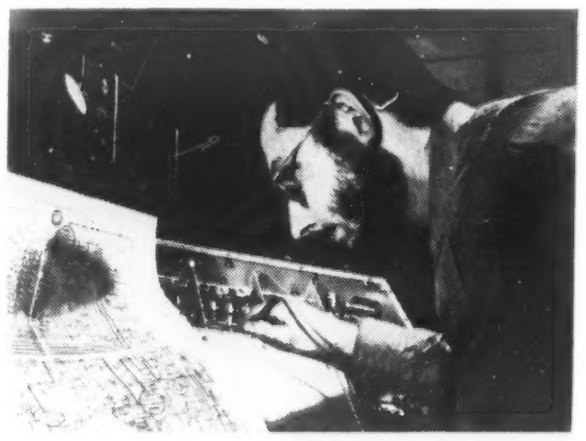
Amateur Radio

From the standpoint of morale, probably the most important phase of antarctic communications is the role of amateur radio. At NAF McMurdo (KC4USV), Byrd Station (KC4USB), Hallett Station (KC4USH) and at the South Pole Station (KC4USN) the services provided by mail and amateur radio afford the only personal contact the inhabitants have with their loved ones and families. Amateur radio becomes very popular during the long winter night, late February to late September. During these many months there is no mail, and all hands are closely confined to the limits of their camps.

Thousands of "ham-grams" and phone patches have been relayed to and from the men in Antarctica in the past four years by unselfish and devoted amateur radio operators throughout the United States. Paul Blum (W2KCR) of Syracuse, N. Y., and Jules Madey (K2KGJ) of Clarke, N. J., have been given official recognition for the outstanding services which they provided men in the antarctic. Most contacts are being made with single sideband in the 20-meter band, although contacts have been made in other bands.

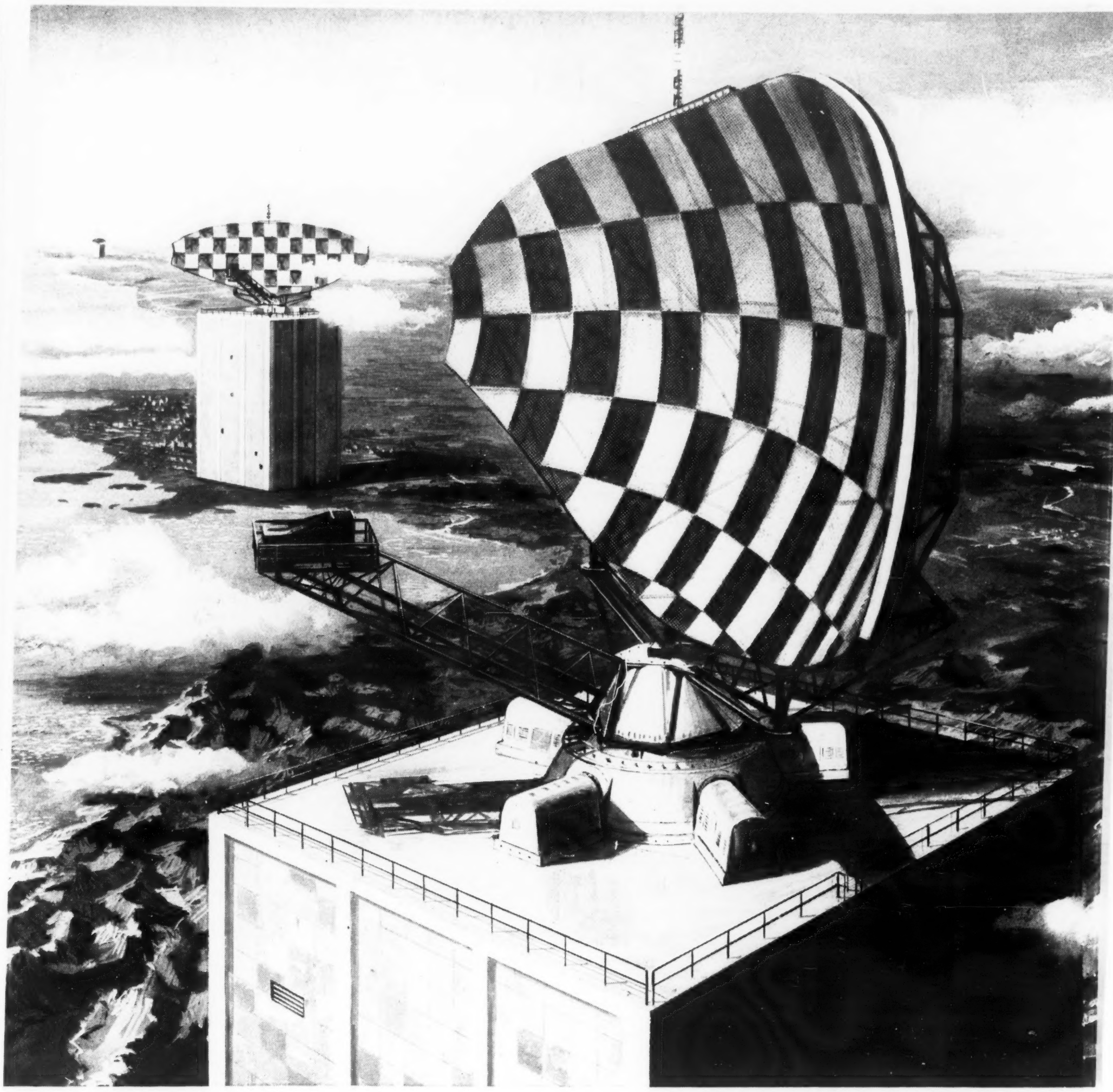
The prospectus of antarctic communications systems is one of continued growth and improvement. With the recent signing of the Antarctic Treaty by delegates of 12 nations interested in the continuation of scientific exploration of Antarctica, it becomes apparent that even greater expansion of existing communications facilities will be necessary to facilitate the rapid and efficient fulfillment of operational commitments.

Now that the operation has achieved a more permanent status, efforts are being made to ensure that every station will have the capability to carry out its assigned mission with the high standards of performance and reliability inherent in U. S. Naval Communications.



(1) Amateur Radio Station KC4USV, NAF McMurdo.
(2) Two Navy men stand watch at transmitter hut.
(3) Trouble shooting teletype equipment at transmitter hut.

3



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Dominating its environment is a Sperry Area Search Radar – one of a network which will strengthen America's Continental Aircraft Control and Warning System. Twenty-four hours a day the year round, these giant sentinels stand guard searching the skies for possible "hostiles."

This is one of many advanced Sperry radar systems. Others are tracking and guidance radars for the Navy's Terrier and Talos missiles . . . airborne navigation and weather radars for the Air Force . . . portable and airliftable tactical early warning radars for the Marine Corps . . . tiny battlefield surveillance radars for the Army footsoldier. And in commercial shipping, Sperry radars are guiding all types of vessels from the luxury ocean liner to the harbor tug.

Sperry capabilities in radar and component technology in such fields as microwave instrumentation, klystron and traveling wave tubes, ferrite devices, semiconductors and many other specialized fields related to radar continue to advance the art of precise detection . . . and direction. General offices: Great Neck, New York.

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SPERRY 50 YEARS

SIGNAL·GRAM

— GOVERNMENT —

HAWAIIAN OBSERVATORY dedicated June 23, 1960 at Ewa Beach, Island of Oahu, is the tenth such facility operated by the U.S. Coast and Geodetic Survey. The Honolulu Magnetic and Seismological Observatory will serve as an important geomagnetic station in the Pacific and will be a vital link in the Survey's vast program of locating earthquakes throughout the world.

EIA REPORT TO FCC on the radio frequency needs for space communications in the bands above 890 mcs holds that satellite communications systems and surface point-to-point communications systems can operate on the same frequencies without causing harmful interference to each other. The Microwave Section of the Electronic Industries Association presented its findings in public hearings conducted by the Federal Communications Commission, July 18.

PIONEER V AND TIROS I are no longer sending data to earth, although both satellites are still orbiting. Pioneer V, the aluminum space laboratory launched March 11, used a 5 watt transmitter and a 150 watt transmitter to exceed the previous long distance communication record of 407,000 miles by more than 55 times. On June 26, the date of its last transmission, the space vehicle was 22.5 million miles from earth. The experimental meteorological satellite, Tiros I, transmitted over 22 thousand photos showing cloud formations, storms and other weather data before reaching the end of its three-month operating lifetime, July 1. Tiros I, which takes its name from television and infrared observation satellite, contained a wide angle camera and a narrow angle camera, but did not carry infrared sensing equipment. Tiros II, believed to be launched soon, is expected to have infrared sensors.

ARMY PORTABLE RADAR SYSTEM designed to look far behind enemy lines and provide photographic plots of battle information has been developed for combat troops. The 600-pound system will sweep enemy-held territory in a 25-mile semicircle and determine whether an enemy attack is impending or a withdrawal is in progress. In actual operation the system will be transported by helicopter to a point overlooking enemy terrain, where a three-man crew would set up the three-piece antenna and assemble the equipment. The first model of the system has been turned over to the Army Combat Surveillance Agency of the U. S. Army Signal Corps for field experiments.

AT THE PROPOSED NBS LABS to be located at Gaithersburg, Md., construction of the first two laboratory buildings will be completed sometime in 1963. These buildings, which will house an engineering mechanics laboratory, a radiation physics laboratory and a power plant, were given priority among the 20 buildings to be constructed in the total relocation program because of their urgency in national science activities, the National Bureau of Standards announced. The General Services Administration, which is responsible for the construction program, expects to award building contracts toward the end of 1960. The total program calls for the construction and equipping of laboratories to replace those now located in Washington, D. C., as well as the construction of such new facilities as a nuclear research reactor.

NASA LAUNCH OPERATIONS will be coordinated by a Launch Operations Directorate (LOD) which became operational July 1 when the Development Operations Division of the U. S. Army Ballistic Missile Agency was formally transferred to NASA as the Marshall Space Flight Center. LOD will function as the central National Aeronautics and Space Administration group at both the Atlantic Missile Range and the Pacific Missile Range for all matters relating to over-all vehicle launch operations and will act as the official NASA contact with range commanders and their staffs.

AIR FORCE WILL TEST AUTOMATIC TUTORING MACHINE in a 15-week course in basic electronics at Keesler Air Force Base, Biloxi, Miss. Called the AutoTutor, this machine is designed to increase speed and accuracy in learning a wide variety of subjects. Developed by Western Design, a division of U. S. Industries, Inc., the AutoTutor resembles a microfilm machine.

THE ARMY'S longest direct high-frequency radio circuit line was opened on the one hundredth anniversary of the U. S. Army Signal Corps. The Australian Military Forces Director of Signals operates the Australian terminal at Melbourne. The American terminal is at Davis, California. The single radio circuit channel is the only link established by the Army with a foreign government.

MOBIDIC COMPUTER will be used to speed up supply processing and tighten stock controls for the U.S. Seventh Army in Germany. MOBIDIC, the mobile digital computer, will be able to do a job for the Seventh Army which the present computer, working around the clock, cannct handle. This is the belief of the U.S. Continental Army Command, the organization responsible for providing equipment for Army units in the field, which has scheduled the MOBIDIC for delivery to the Seventh Army next fall. Army planners estimate that a 14-hour work load for the commercial computer now in use can be accomplished by MOBIDIC in an hour and a half. Another advantage of the MOBIDIC is that it can function in rugged terrain and weather environments, anywhere, since it is fully transistorized.

CONTRACTS: ARMY: Gilfillan Brothers, Inc., telemetry equipment and production engineering services on the Sergeant surface-to-surface missile, $1.3 million; Budd Electronics, Inc., subsidiary of The Budd Co., radio relay equipment, $1.2 million; Massachusetts Institute of Technology, one year's basic and applied research in electronic and molecular physics and communications, $1 million. NAVY: General Dynamics Corp., Electric Boat Div., construction of three nuclear power attack submarines, $59 million; General Electric Co., Heavy Military Electronics Dept., production of long-range height-finding radar units which have a three dimensional capability to simultaneously detect the range, azimuth and height of a target, $14 million; Hughes Aircraft Co., construction of guidance systems for Polaris fleet ballistic missiles, $7.5 million; General Dynamics Corp., Stromberg-Carlson Div., production of transistorized airborne radio equipment, $4 million; Raytheon Co., development of sonar systems for nuclear submarines and production of shipboard training sonars, $1 million. AIR FORCE: National Carbon Co., division of Union Carbide Corp., three-year research and development contract on graphite for missile and space vehicle components, $12 million; Avco Corp., Crosley Div., production of spare parts to be used on bomber fire control systems, $8 million; Missile Systems Corp., exact scope of work is classified, but the equipment to be supplied relates to the nation's nuclear armament program, $2.1 million.

— INDUSTRY —

OPTICAL DEVICE which can focus light into high-intensity beams for space communications is being developed independently by various companies. The new solid-state electronics device is called a LASER, from Light Amplification by Stimulated Emission. "The Laser's use in radar and communications for space work is obvious since there is no atmosphere in space to absorb or scatter the beams. The high resolution resulting from its sharp beams would enable man to take detailed 'pictures' of any area. For example, a beam directed at the earth from a satellite 1,000 miles up could be concentrated in an area about 200 feet wide," according to Hughes Aircraft Co., one of the companies doing work on the device. Other firms engaged in Laser work are Bell Telephone Laboratories and TRG, Inc. Columbia University also is working in the Laser area.

RCA RADAR STUDY may aid Project PRESS, a program to determine the capability of radar and other devices in the detection and identification of ballistic missile warheads. The objective of the Radio Corporation of America study, which will be performed under an Army contract, will be to draw up the design specification of a data handling and a computer complex which will assimilate and process all data acquired on Project PRESS.

COLLINS RADIO CO. has developed a new airborne high frequency single sideband transceiver which can provide world-wide communication on 28,000 channels. First shipments of the 618T unit, which delivers 400 watts peak envelope power on single sideband and also provides a 100 watt carrier for conventional AM operation, will begin this month. The unit is said to have a greater signal-to-noise ratio than conventional AM.

PHILCO CORP. will produce and modify a height finder radar system for the Airborne Long Range Input system (ALRI). ALRI is a system to provide the North American continent with a seaward extension of the Semi-Automatic Ground Environment system, a network of radars, data processors and computers which keep decision making centers informed of approaching aircraft. The Philco radar system, which will be housed in a reconnaissance aircraft, should allow a greater coverage for America's early warning lines, Philco officials believe.

(Continued on page 14)

Nerve Centers For A Satellite

Over 25,000 informative cloud-cover pictures have been received from TIROS I since it was launched on April 1. In two months the satellite had completed 1000 orbits and travelled 27,500,000 statute miles. This means not only that TIROS itself has performed as planned, but that the complex problems of command and control, as well as signal reception and processing, have been successfully surmounted. Like the satellite, the special ground station equipments were designed and built by RCA Astro-Electronics Division under the auspices of NASA and technical direction of the U.S. Army Signal Corps.

Major components at each of the four ground stations include:

- Five TV receivers and four beacon receivers used in diversity reception to minimize signal fading
- A programmer which pre-programs different combinations of operating modes, and a 200 watt command transmitter
- A TV monitor to display the picture signal for the automatic recording camera. The camera is equipped to make either positive or negative films
- An indexer and sun angle computer which generate an index number and sun angle indication for each picture, used for geographical orientation
- An attitude recorder which picks up the earth-horizon signal for spin axis position computation
- Two standard 4-channel tape recorders to back up the monitor
- Two paper recorders to monitor forty telemetered satellite parameters
- An antenna programmer which directs the antenna to follow the orbit of the satellite when it is in range of the ground stations

All program functions are timed by a master clock which is synched to standard time signals from WWV. In addition to normal picture direct transmission and record functions, the programmer can also command spin-up. After two months the spin rate had decreased to 9.4 rpm's due to the effect of the earth's magnetic field. On command from the ground, two solid propellent spin-up rockets on the satellite were fired, increasing the spin to 12.8 rpm's.

AED's own ground station was used to process photos from the magnetic tapes for the first one hundred orbits.

The integrated design and development of these TIROS ground stations is an indication of AED's capability in *total satellite systems*. This capability will become increasingly critical as more and more complex satellites and space probes are launched to advance man's understanding and control of his universe. To discover how you can draw on this broad R & D experience, contact the Marketing Manager, RCA Astro-Electronics Division, Princeton, N. J.

The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA

SIGNALGRAM (*Continued from page 12*)

CONTINENTAL ELECTRONICS MANUFACTURING CO. is providing super power radar transmitters for the U. S. Air Force's Ballistic Missile Early Warning System (BMEWS). Under a $3.5 million contract recently received from Radio Corporation of America, prime contractor for the BMEWS project, Continental will supply transmitters for the third BMEWS site at Yorkshire, England. Under earlier contracts the firm is supplying transmitters and related equipment for the first two BMEWS sites at Thule, Greenland and Clear, Alaska. The BMEWS surveillance radar system is designed for detection of attack by enemy intercontinental ballistic missiles.

NUCLEAR WEATHER DETECTOR will be developed by Tracerlab Co. for the United States Weather Bureau under a contract from the Atomic Energy Commission Office of Isotope Development. Called a "Tracersonde" because it utilizes radio-chemical "tracer techniques," the detector will utilize ultra-sensitive radio-chemical detection techniques to determine concentration of ozone in the atmosphere. Ozone is a gaseous form of oxygen used commercially to purify air.

THE ELECTRO NUCLEAR SYSTEMS CORP., a new scientific firm launched recently by a group of Minneapolis engineering executives, will engage in research, development and manufacture of advanced systems and equipment for industry and government programs. Among the areas in which the firm expects to operate are automation, data processing, weapons and missile systems, medical electronics and nuclear electronics.

INDUSTRY PROPOSALS for a field Army ballistic missile defense system are being evaluated by the Army Department and contractors soon will be selected to conduct the feasibility studies on such a system. Objective of the studies will be to provide the field Army with the means of defense against ballistic missiles. Last May the Army Rocket and Guided Missile Agency, Redstone Arsenal, Alabama, prepared technical requirement packets for distribution through Army Ordnanc District Offices to interested contractors on a nationwide basis.

PACIFIC SCATTER COMMUNICATION SYSTEM completed by the Army and Page Communications Engineers, Inc., is now in operation. The 6,500-mile system sends radio signals upward to the ionosphere to bounce back in scattered fashion to earth where a number of receivers are operating. One of the largest of its kind, the system has eight interconnecting stations, extending from Oahu, Hawaii, via Kauai, Midway, Wake, Ponape, Guam and Palau to Luzon in the Philippines, and offers over 99 percent reliability.

RADIO CORPORATION OF AMERICA is producing a four-channel Citizens' Band radio. The radio is designed to operate in the Citizen's Band of frequencies set aside by the Federal Communications Commission for use by the general public. It features four crystal-controlled channels for transmitting and receiving, as well as a tunable receiver covering all 23 channels in the Citizen's Band range.

CHANCE VOUGHT will continue development and manufacture of an advanced actuator system for the Minuteman intercontinental ballistic missile. The actuator promises a new level of reliability and assurance that the Minuteman solid propellant missile will be ready to fire even after it has been stored a long time, according to Chance. Work on the highly-integrated unit will be performed by the firm's Electronics Div., under a $3 million contract from Autonetics, a division of North American Aviation Inc., and associate prime contractor for the over-all guidance system of the missile.

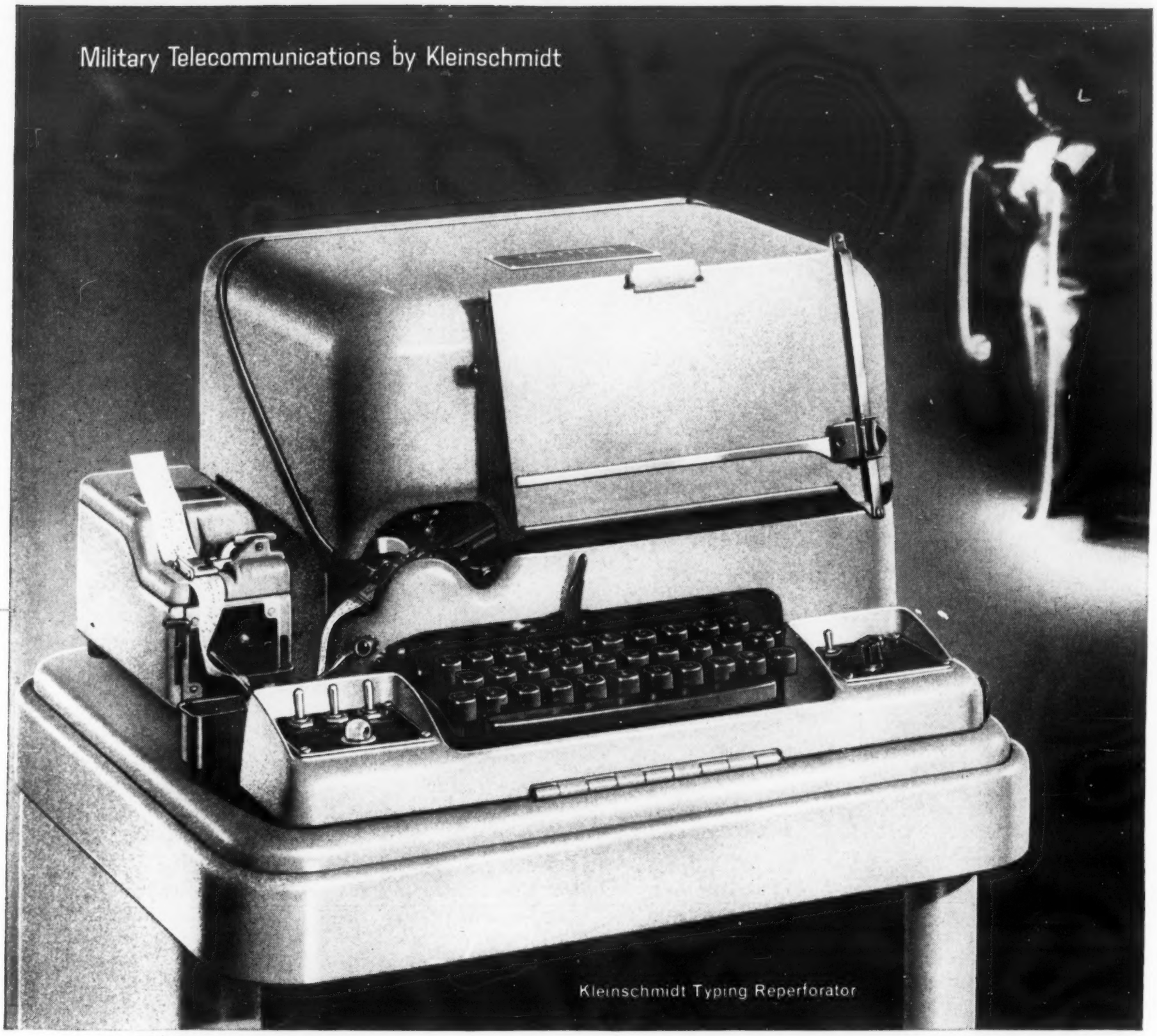
AN INTEGRATED MAPPING SYSTEM will be developed by Fairchild Camera and Instrument Corp. under a $283,116 contract awarded by the Map Compilation branch of the U. S. Army Engineer Research and Development Laboratories. The mapping system will supply contour information, orthophotographs and a permanent record of profile information. This information will be obtained by simultaneously converting the output from a standard stereo plotter into mechanical, optico-electric and electronic energy, respectively.

AN EARTH-BOUND EXPERIMENT which will put a man under conditions which he would face in outer space is being developed by Lockheed Aircraft Corp. at its Human Factors Research Laboratory in Marietta, Ga. Called a "null-gravity simulator," the research project will give the world a preview of how man will react, work and sleep while floating weightlessly through outer space for long periods of time.

GENERAL TELEPHONE & ELECTRONICS CORP. has established a Washington, D. C. office which consolidates the Washington operations of its subsidiary companies.

(*Continued on page 16*)

Military Telecommunications by Kleinschmidt



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A tape transmitter, typing reperforator and keyboard transmitter—all in a single compact unit! Besides sending and receiving messages in perforated tape form, this Kleinschmidt unit also provides for tape preparation, editing, reproduction and direct line keyboard or tape transmission. Kleinschmidt's complete line of fine equipment, switching centers and systems are in U.S. Military use throughout the world. *Call now to arrange for a discussion with our systems and equipment engineers.*

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— GENERAL —

SOLAR TELESCOPE AT KITT PEAK NATIONAL OBSERVATORY near Tucson, Arizona will provide "more revealing views of the sun than have ever been possible from earth," stated Dr. Alan T. Waterman, Director of the National Science Foundation. Construction work begins this month and the telescope will be completed in about two years. The instrument will have a focal length of 300 feet and will form images of the sun several times larger and more brilliantly illuminated than are attainable with any other solar telescope, according to NSF which is supporting the Kitt Peak solar program. The observatory was dedicated last March.

COATED FABRIC BALLOONS which inflate in one-tenth of a second have been developed for a high-altitude recovery system designed to control deceleration of re-entry vehicles. The spherical drag balloons are to be used to retard tumbling and to control speed of instrumented nose cones, manned escape capsules and other orbital vehicles during re-entry through the "heat barrier" of the earth's upper atmosphere. A parachute is ejected at lower altitudes to complete the recovery. Goodyear Aircraft Corp. developed the balloon-parachute system for the Air Research and Development Command's Wright Air Development Division.

DATA TRANSMISSION PROBLEMS will be discussed at a symposium to be held at Delft, Netherlands, September 19-21. American, French, British and Dutch engineers will present papers on communication feedback techniques, detection of telegraph signals and related topics. The symposium is being sponsored by the Institute of Radio Engineers and two Dutch groups.

PORTABLE TELEPHONE SWITCHBOARD has been delivered to the U. S. Army Signal Corps, a communications switching symposium was told recently. Believed to be the first miniaturized air conditioned electronic telephone switchboard of its type, the 200-line unit can be transported in a 2 ½ ton truck and operated in any climate. The unit, which weighs 5,390 pounds, shows a two-thirds weight reduction over similar electro-mechanical units. This data was presented at the Summer General Meeting of the American Institute of Electrical Engineers.

SINGLE SIDEBAND HAM CONTEST is scheduled for September 10 and 11. Sponsored by the SSB Amateur Radio Association of Lynbrook, N. Y., the primary object of the contest is to work as many single sideband stations in as many of the 50 states as possible via two-way single sideband within the prescribed time. Any amateur using single sideband equipment is eligible to compete.

TITANIUM MOTOR CASING for the Minuteman intercontinental ballistic missile has been successfully static test fired by Aerojet-General Corp. who developed the casing. Titanium, a lightweight metal, was used for the casing of the solid-fuel motor for the third stage of the Minuteman, a surface-to-surface solid propellant weapon developed by the Air Force. This was the first time that a large rocket motor with a titanium casing has been fired in full-scale, full duration static tests. The success of this test may mean that the range of the Minuteman can be increased, according to Aerojet, since the distance a missile travels is somewhat dependent upon the weight it carries. The titanium motor casing is one-third lighter than regular steel casings.

AUDIO VISUAL EQUIPMENT FOR USE IN EDUCATION will be evaluated at a conference to be conducted by the Society of Motion Picture and Television Engineers, under a grant from the United States Office of Education. At the conference educators and engineers will study the suitability of present audio visual devices in terms of educational needs and they will formulate engineering principles for the development of future devices to be used in teaching.

REMOTELY CONTROLLED COMPUTER capable of 50 thousand computations a second will be installed in Carnegie Institute of Technology's Computation Center next fall. Since the computer can be remotely controlled from different buildings on the campus, the various research centers can supply data to the computer and evaluate results from operating positions outside the computation center. Known as the G-20 high-speed data processing system, the system was developed by Bendix Aviation Corp. It includes magnetic tape units that read and write at a rate of 120,000 digits per second.

CALENDAR OF EVENTS

AUGUST 23-26: Western Electronics Show and Convention, sponsored by Institute of Radio Engineers and West Coast Electrical Manufacturers Association, Ambassador Hotel and Memorial Sports Arena, Los Angeles, California.

AUGUST 29-SEPTEMBER 3: International Information Theory Meeting, sponsored by Institute of Electrical Engineers and Institute of Radio Engineers, London, England.

SEPTEMBER 9-10: Conference on Communications, sponsored by Institute of Radio Engineers, Roosevelt Hotel, Cedar Rapids, Iowa.

COMPUTENCE

total competence in computation and data processing—the breadth, the brains and the background

The term: created by necessity to distinguish the new concept in computation—the computation of Burroughs Corporation. **Domain:** weapons systems, support systems for space, air, land and sea. **Qualifications:** 75 years devoted to computation and data processing; membership on Polaris and Atlas teams; system management of the ALRI team; facilities that range from basic research through production to field service. **Credentials:** high-speed computation for Polaris, miniaturized airborne data processors for ALRI, the Atlas computers that guided Explorer I, Transit and Midas satellites into orbit. **Destination:** the unknown, where total competence in computation and data processing crystallizes into Comp**u**tence to point the way.

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Additional Convention Photos

(OPPOSITE PAGE, top row) Cdr. Albert Kunz, USN, Ray Meyers, Maj. Gen. Harold Grant, USAF, Maj. Gen. Spencer Akin, former CSigO, Maj. Gen. George Back, former CSigO, Maj. Gen. R. T. Nelson, USA, Benjamin Oliver, Jr., AFCEA President, RAdm. Frank Virden, USN and Maj. Gen. Harry Ingles, former CSigO, at Ham Station. (second row, left) George Bailey and Gen. Back at Ham Station. (second row, right) Gen. Lyman Lemnitzer, USA, Chief of Staff. (third row and fourth row) Exhibits. (ABOVE, first row, left) Benjamin Oliver, Jr., AFCEA President, Maj. Gen. R. T. Nelson, USA, and Ray Meyers. (first row, right) Bus leaving for tour of Naval Research Laboratory. (second row, left and right) Scenes taken during exhibit hours. (third row) Keynote Luncheon.

DESIGN WITH ARNOLD 6T CORES . . . SAME-DAY SHIPMENT OF STANDARD DELTAMAX CORE SIZES

Arnold 6T tape cores (aluminum-cased and hermetically-sealed) offer you three very important design advantages. *One:* Maximum compactness, comparable to or exceeding that previously offered only by plastic-cased cores. *Two:* Maximum built-in protection against environmental hazards. *Three:* Require no supplementary insulation prior to winding and can be vacuum impregnated after winding.

Now we've added a fourth vital advantage: Maximum availability. An initial stock of approximately 20,000 Deltamax 1, 2 and 4-mil tape cores in the proposed EIA standard sizes (See AIEE Publication No. 430) is ready on warehouse shelves for your convenience. From this revolving stock, you can get immediate shipment (*the same day order is received*) on cores in quantities from prototype lots to regular production requirements.

Use Arnold 6T cores in your designs for improved performance and reduced cost. They're guaranteed against 1000-volt breakdown . . . guaranteed to meet military test specifications for resistance to vibration and shock . . . guaranteed also to meet military specifications for operating temperatures. The 6T hermetic casing method is extra rigid to protect against strains.

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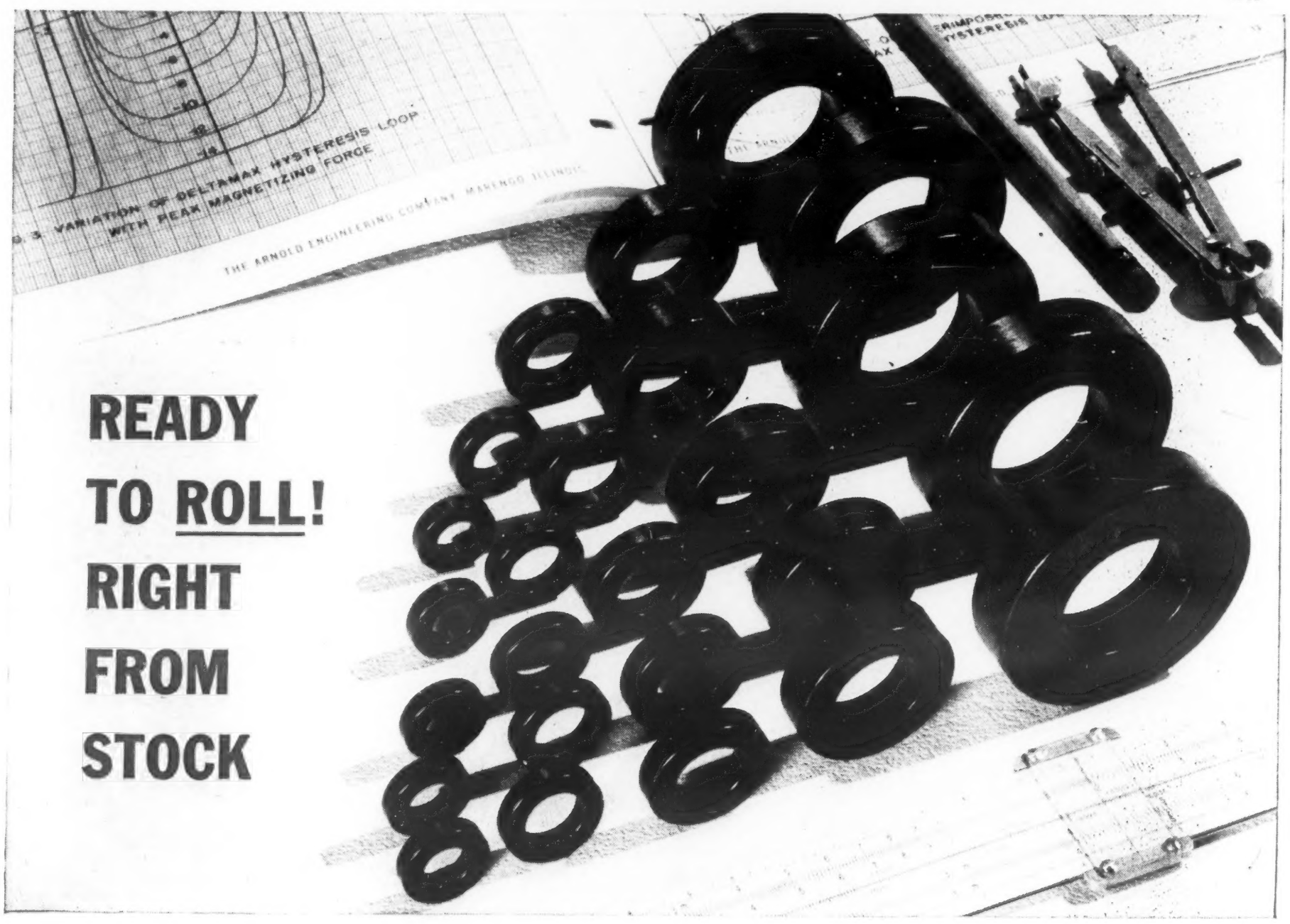
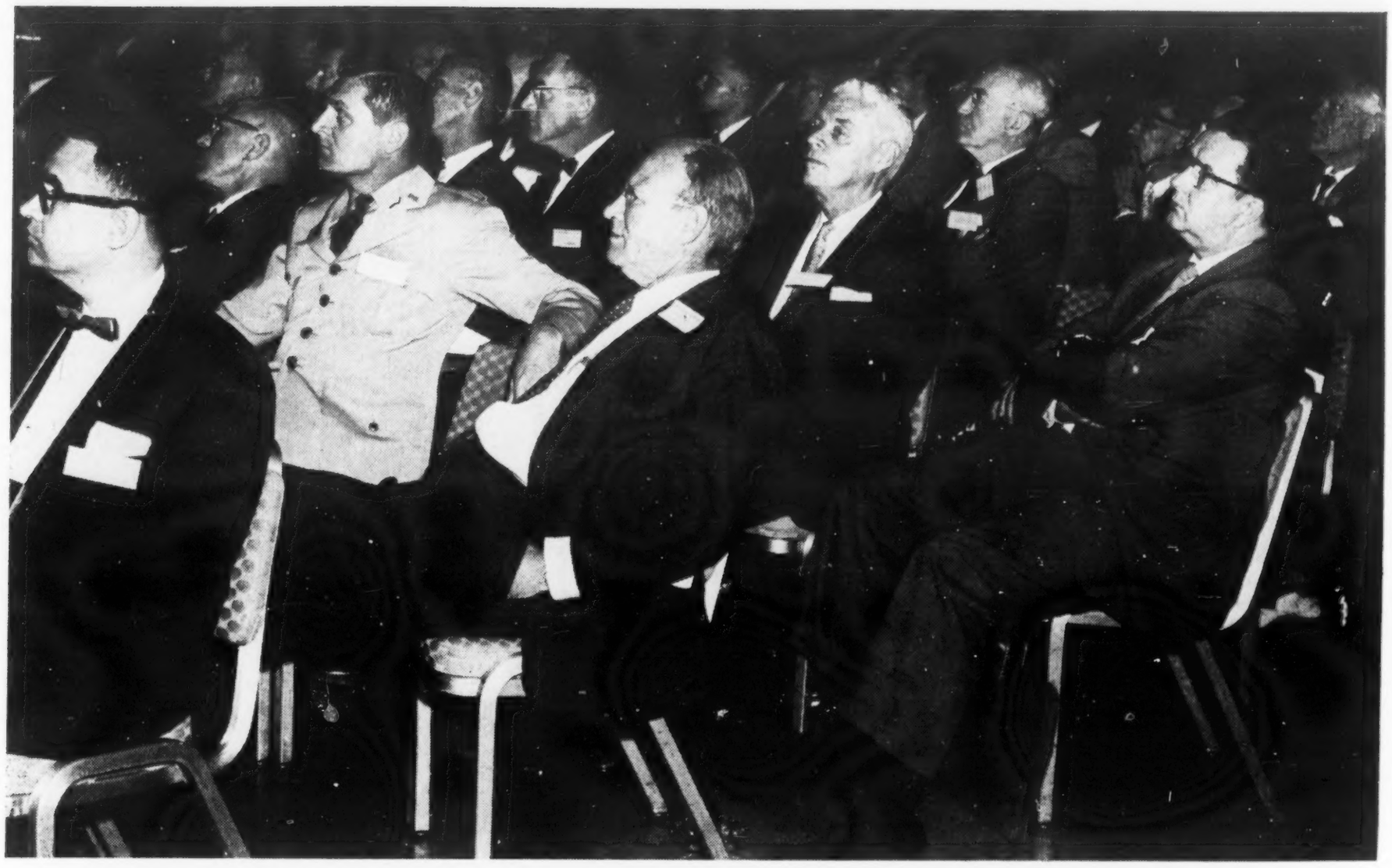
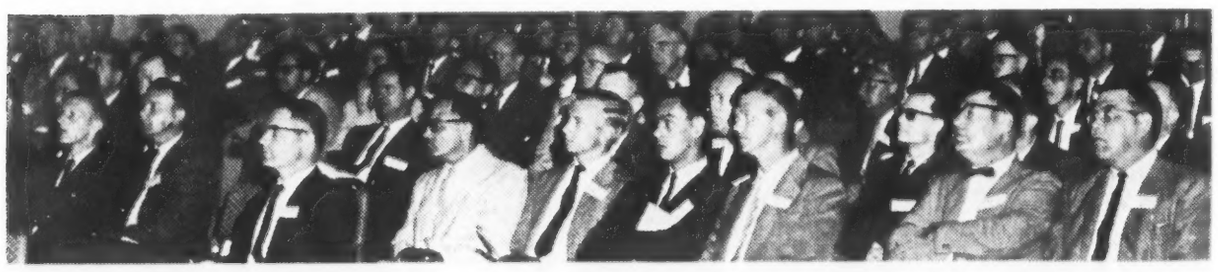


READY TO ROLL! RIGHT FROM STOCK



PANEL DISCUSSIONS

Panel Discussions were a vital part of the 14th Annual AFCEA Convention. Leading authorities outlined various phases of research and development in the areas of communications, electronics and photography. Last month SIGNAL published two of the four 1960 discussions—"Communications and Electronics for Putting a Man into Space" and "Space Communications." Appearing in this issue are 'Scientific Applications of Photography" (page 22) and "Industry Reports" (page 31).



Panel I
Scientific Applications of Photography

MODERATOR—RADM. ROBERT S. QUACKENBUSH, USN (RET.), ENGINEERING DIV., POLAROID CORP., INTRODUCED BY RADM. DWIGHT M. AGNEW, USN (RET.), WASHINGTON ASSOCIATES

AN INTEGRATED ELECTRONIC SYSTEM FOR AERIAL PHOTOGRAPHY AND MAPPING

BY H. SCHOENE, S. SHERR, GENERAL PRECISION LABS. AND H. MEIER, AERO SERVICE CORP. SPEAKER: H. SCHOENE

IN MODERN AERIAL PHOTOGRAPHY and mapping, there is a broad array of electronic devices available for utilization which potentially can provide a capability for extremely high level performance and accuracy. These devices can truly enhance the photographic process. However, in order to achieve an optimum effectiveness, the total complex must be approached from an integrated system point of view which properly combines and applies these various equipments. The absence of such an integrated approach can result in two undesirable situations.

First, the full capability of the equipment will not be utilized and mission performance will fall short of that demanded by present photographic and mapping needs.

Second, these electronic aids may actually deter and impede the mission activity because of improper application, operational difficulties and inadequate understanding of the characteristics of the equipment being employed.

The goal of optimum system integration is to be able to meet the operational requirements for the over-all system while utilizing equipment, particularly existing equipment, in the most efficient manner. This efficiency can result in improved accuracy, increased reliability, and appreciable cost savings. Too often costly and time consuming developments are undertaken when the same result can be achieved with appropriate modifications to adjusting proven equipment.

It is for this purpose of achieving effective utilization of available and new equipment that the system to be described has been designed. The system achieves a performance capability significantly beyond that of present systems and therefore permits meaningful improvements in photographic results as well as appreciably simplifying operational procedures. This capability will also highlight the general advantages of an integrated approach to the system designed for any purpose or any set of requirements.

While the major emphasis is on the proper use of existing equipment, this does not preclude the use of items still under development or to be developed. Indeed, the integrated approach may bring to life needs and lacks which were not apparent from a piecemeal combination.

In order to achieve the advantages of this approach, General Precision, Inc. and Aero Service Corporation have completed a study of the required program for modernizing an aerial photographic mapping system. In this study a three-step sequence was followed. First, each of the techniques and procedures now employed was examined to determine where improvements were most needed, with particular attention paid to uncovering those system limitations which are attributable to equipment shortcomings and peculiarities. Second, the capabilities of current state of the art equipment were projected into the system and it was noted how operational procedures might be changed in order to improve mission operations. Having thus established objectives for the program, the third step was to investigate the applicability of existing equipment and equipment being developed under other programs.

As a result of this analysis, it was concluded that several major replacements were essential. But by careful selection and utilization of existing equipment, the amount of new development required could be reduced to a minimum.

Significant conclusions were:

1. That some of the equipment previously proposed for this application, when used individually, have distinct limitations which could preclude meeting system performance requirements under certain operational conditions.

2. That if these same equipments are properly integrated, not only will system performance exceed by far that which was originally expected, but, in addition, the system will lend itself to the development of new operational techniques which afford considerable advantage in photo mapping missions.

Let us consider first some of the major requirements of a modern photo mapping mission: a highly accurate vertical stabilization of mapping cameras; accurate, reliable and versatile self-contained navigation; dependable means for providing both horizontal and vertical control; co-ordination and integration of control functions, enabling missions to be performed effectively with a minimum crew; airborne digital data recording on magnetic tapes with assurance that all recorded data are both complete and valid; and compatibility of the airborne recorded data with the use of electronic computers for ground data reduction.

I believe that there is various equipment which might be employed to meet the requirements. Of prime importance is a stabilized mount for the mapping camera with a specially designed photogrammetric vertical reference unit. Drift angle data for azimuth stabilization could be obtained by use of the optical view finder, the TV view finder, or by the drift angle output of the Dopplar radar. Self-contained navigation capabilities exist in the available Dopplar radar, astro compass, magnetic compass, and ASN-24 airborne digital computer combination.

Other major equipment blocks are a digital magnetic tape recorder subsystem, the electronic distance-measuring equipment for horizontal control, the airborne profile recorder for vertical control, and the various meteorological sensors for measuring pressure, temperature, humidity and air speed. It is the task of the system designer to integrate these various equipments and capabilities into the system which achieves greatest effectiveness in performing the required mission functions.

The performance characteristics of some of these equipments are of considerable interest. For example, a photogrammetric vertical reference unit is now being developed which will be capable of maintaining the verticality of the mapping camera to within three minutes of arc. This is the RMS error. Now this in itself is a major advancement in the state of the art of photomapping. However, the attainment of this accuracy is dependent upon performing a ground alignment before taking off. In addition, the undamp inertial loop is subject to long-term cyclic variations. Although it is far better than existing vertical references, ground rectification of the resultant photography is still required to achieve

the utmost in accuracy.

Another example of individual equipment limitations exists in the components available for a self-contained navigation capability. In order to derive full advantage from this capability, particularly in those missions requiring straight flight line, it is essential that the maximum possible accuracy be attained. In most navigation systems, including the system discussed here, the major problem is to attain a highly accurate heading reference. Under certain operational conditions, the astro compass will provide the accuracy required. However, there are conditions where the accuracy of its heading output will be degraded appreciably. The accuracy of the astro compass is dependent upon two variables: the vertical stabilization of its tracking unit and the altitude or angle from the horizon of the celestial body which is being tracked. The error in the heading output is proportional to the error in the vertical times the tangent of the altitude.

During night-time operations when there is a wide selection of stars available, this heading error is minimized by selecting only low altitude stars. However, in daytime operations the astro compass is limited to tracking the sun. Particularly at the lower latitudes where the sun is high in the sky during the mid-day hours, the heading output is not satisfactory for the accuracy required.

It should be noted that although the tilt of the mapping camera is held to a very small value by the vertical reference unit, the error in vertical stabilization of the astro compass tracking unit can be appreciably higher due to errors in transmission and due to aircraft flexure. The vertical reference unit which is on the same mount as the camera will necessarily be on the deck of the aircraft, whereas the astro compass necessarily will be mounted on the overhead.

At those times when the astro compass output is not satisfactory, it is necessary to have an alternate source of heading. The magnetic compass system is available, but it is not sufficiently accurate. The Doppler radar likewise has its limitations. It derives ground velocity information by transmitting microwave radiation to the ground and measuring the Doppler shift in the return signal. The velocity measurement is very accurate when averaged over distances greater than a few miles. However, in applications requiring very accurate instantaneous velocity information, the Doppler signal does not contain the needed high frequency components due to the inherently noisy character of the return signal.

Each of these equipments, therefore, presents unique problems when used independently of the other. These problems were overcome by the integration of the navigation components and the photogrammetric vertical reference unit. In this integration, advantage is taken of the fact that the vertical reference unit is, in essence, an inertial platform. With relatively minor modifications to the electronics and with the substitution of currently available gyros having low drift rates, a Dopplar inertial system is formed, which has several very significant features.

This combination results in ground velocity components which are continually accurate. In addition, the combination permits the determination of aircraft heading by means of a technique known as gyro compassing. This consists essentially of sensing the direction of the aircraft longitudinal axis with reference to the axis of the earth's rotation, which is, of course, north-south. The accuracy of this heading determination is best at lower latitudes. Taking, for example, an aircraft flying at 300 knots at North 45 degrees latitude, the RMS error of gyro compass heading is 6.8 minutes of arc. This accuracy improves at lower latitudes and degrades at higher latitudes. Gyro compassing is thus an ideal adjunct to the astro compass.

The most significant feature of the Dopplar inertial interconnection is that the error in vertical is bounded by the Dopplar—such that the RMS value of resultant camera tilt is less than 0.5 minutes of arc and this can be obtained without any previous ground alignment. The advantages of this degree of stabilization are obvious.

It should be noted that this Dopplar inertial interconnection, which provides gyro compass heading, continuous velocity accuracy, the improved vertical, and also eliminates the need for ground alignment, was obtained without the addition of any equipment. All the necessary computation can be performed by the ASN-24.

With its self-contained navigation capability, the system permits flight-line navigation for both electronically controlled and uncontrolled photography, without reference to ground stations. One hundred and fifty miles photo flight lines can be flown without position fixes and the one sigma value of side graph error will be 3,000 feet. In order to permit longer, essentially indefinite flight lines to be flown in controlled photography, automatic position fixing is provided. Again, without any additional equipment.

At the start of the flight the co-ordinates, that is latitude and longitude of appropriate D and E stations, are stored in the digital computer. These are the same stations that are used for electronic control of the photography. Whenever a position fix is required, the computer automatically ascertains the position of the aircraft from inputs of the slide range distances to these stations and from input of pressure altitude. It then determines whether the aircraft is on the desired flight line and makes the appropriate correction, if required.

The availability of self-contained navigation and accurate velocity data suggests a means for reducing the stringent requirements now imposed on the location of D and E stations and additionally could reduce the number of stations required for a given mission. By processing the velocity data, the distances between successive photographic exposures can be determined accurately and could be used in photogrammetrically bridging the areas of inadequate station angle coverage. This, and many other techniques, such as automatic overlap control, accurate and automatic azimuth stabilization of the camera mount, airborne computation for in-flight data verification, and improved APR operations, are now feasible with the integrated system.

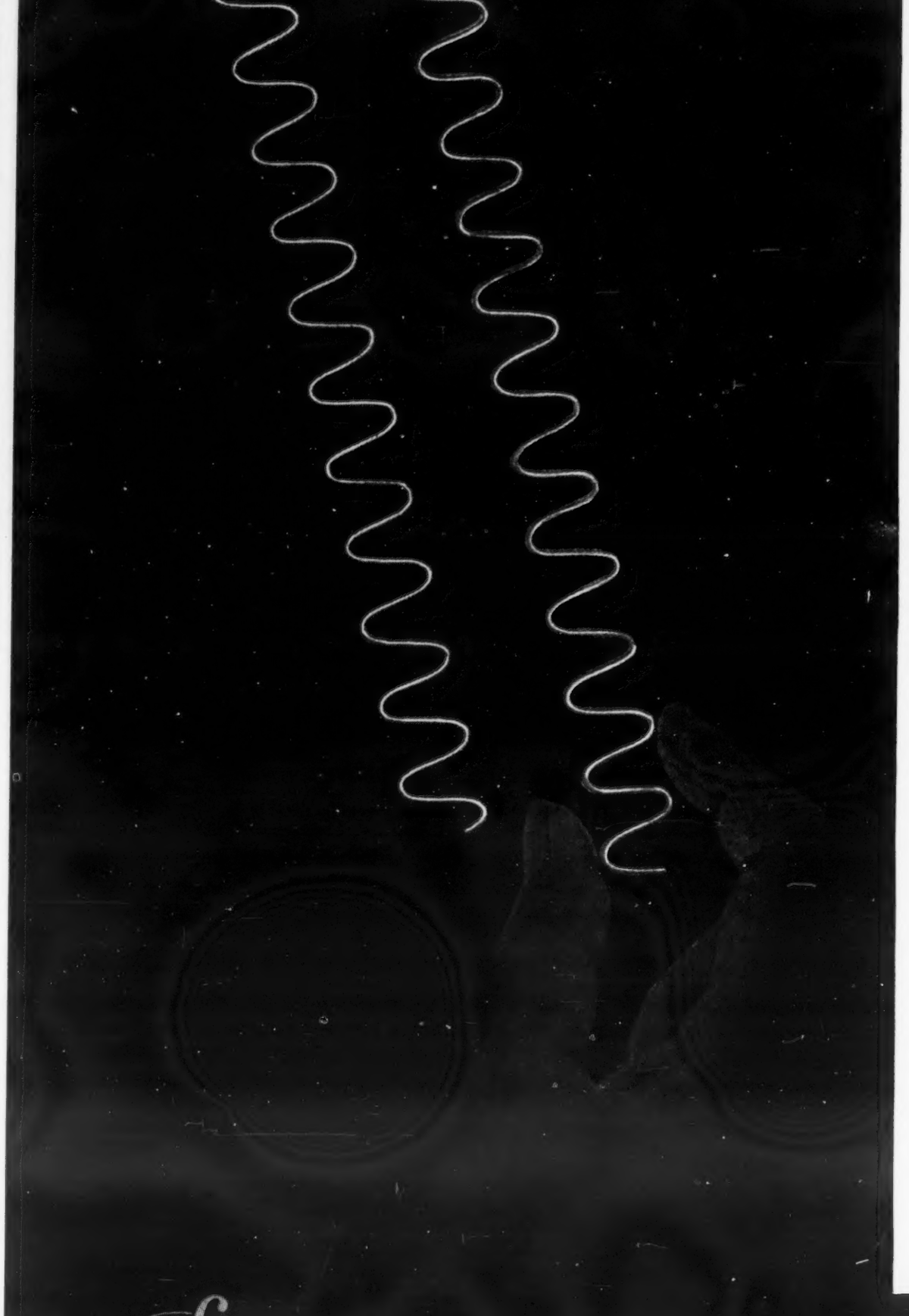
The digital magnetic tape data recorder sub-system is designed to collect, store, organize and record all information necessary for the ground computer solution of the various mission tasks. Up to 80 channels of information can be interrogated and recorded within one-half second on 2½ inches of magnetic tape. The recorder also has provision for simultaneous recording of selected channels.

Typical data to be recorded, which include both fixed and varying perimeters, are project number, aircraft number, date, mission number, mode of operation, line number, SCP number, mapping camera film number, APR camera film number, DME distances, drift angle, latitude, longitude, distance traveled, temperature, humidity, terrain clearance, radio altitude, and time, among others. It is to be noted that the recorder has a self-checking feature to insure that all the data are recorded. In addition, the digitizing circuitry for the various sensors contains provision for automatic calibration checks to insure that data are valid.

The integrated dual control and display console, designed for the navigator and the equipment operator, with appropriate human factors engineering permits the entire mission to be carried out effectively with a three-man crew, the third man being the photographer.

Among the advantages of system integration such as efficiency, performance capability and versatility, is reliability which must be designed into the system with the utmost degree. This is perhaps the most important contributing factor toward meeting the goal of high mission productivity. It can be achieved most effectively through the use of present-day techniques and equipment, properly combined and utilized as a result of applying advanced integration procedures.

In conclusion, the previously stated requirements of a modern photo-mapping mission are met by this new system with significant improvement in vertical camera range, navigational capabilities and data recording compatibility. These improvements are achieved with relatively minor modifications to available equipment and with the minimum number of new designs. It is a system which makes possible major advances in photogrammetry and highlights what can be achieved by proper system design and integration.



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TIROS PAYLOAD AND GROUND SYSTEM

SPEAKER: DR. MORRIS TEPPER, CHIEF, METEOROLOGICAL HDQS, NASA

APRIL 1, 1960 will go down in meteorological history as one of its more important days. On April 1, 1960, the United States successfully launched its first meteorological satellite, Tiros I. The speakers this morning represent some of the key organizations that participated in this memorable event.

I would like first to make some general remarks concerning the NASA Meteorological Satellite Program. The over-all objective of this program is to establish a meteorological satellite capability for world-wide coverage which would provide those observations required by the meteorologist in order to increase his understanding of atmospheric processes and improve his ability to predict the weather. Satellite observations that are being considered include those of cloud cover, storm location, precipitation, temperatures, wind directions, heat balance, water vapor and other constituents, and some extra-terrestrial observations related to the earth's atmosphere.

It is the NASA state of intention to be responsive to the reaction and recommendation which the scientific community may have relative to the planning phases of this program. To achieve this objective will require:

(a) The development of earth stabilized satellites for polar orbits of from 500 to 1,000 mile altitude and stationary satellites for equatorial orbit of 22,000 mile altitude.

(b) The development of suitable onboard detection equipment, including television, infra-red radiation detectors, radar, tachrometer, and detectors of short wave length radiation.

(c) The development of adequate data storage handling and communication equipments and techniques.

In view of the wide scope of objectives which I have just stated, and the many technological developments which have yet to come into being before we are able to realize these objectives, it is apparent that Tiros I must be viewed as no more than a primordial representation of the ultimate meteorological satellite. It is indeed only an elementary first step in the direction of attaining our objectives. It contains only one useful meteorological sensor, the television system for cloud cover identification. It is space stabilized so it does not always look directly at the earth. It can take pictures only of the sunlit regions of the earth. It is in an inclined orbit around the earth so that we will get no data from the upper temperate and polar latitudes. It has a limited lifetime, probably of the order of three to five months.

Despite the fact that Tiros I provides only a small step forward in the over-all NASA meteorological satellite program, it is indeed a most significant first step. I am certain that all of you here have seen some of the pictures transmitted by Tiros I and I know you share our excitement for the potential which Tiros I indicates we may expect from future meteorological satellites. With regard to Tiros I, there now remains the exciting task of extracting from the photographs useful information on the structure and perhaps even the behavior pattern of atmospheric phenomena.

Tiros I has been a truly national effort. I don't think I would be able, even if I had the time, to name for you all of the participants in this program, both government and industrial. However, I would like to mention the general areas of participation and associated responsibilities.

Tiros had its origin as a meteorological satellite in the Department of Defense under the cognizance of the Advanced Research Projects Agency (ARPA). A little over a year ago the program was transferred to NASA. The responsibility for the technical management was vested in the Goddard Space Flight Center of NASA. However, the primary co-operating agencies remained unchanged. The Ballistic Missile Division of the United States Air Force and its contractors, the Space Technology Laboratories and the Douglas Aircraft Corporation, had the responsibility for developing and launching the launch vehicle, the Thor-Able. The payload development was under the direction of the United States Army Signal and Research and Development Laboratory at Fort Monmouth and its primary contractor, the Radio Corporation of America. The Signal Corps also had the responsibility for data acquisition and communications. Here they had the assistance of the Ballistic Missile Division and the Lockheed Aircraft Corporation in the operation of one of the readout sites at Kaena Point. Tracking, orbit calculation and operations are the responsibility of the NASA Minitrack net, computing center and control center, respectively. The data processing and interpretation are being done by the United States Weather Bureau, the United States Air Force Cambridge Research Center and their contractors, and the United States Navy Photographic Interpretation Center and by Goddard Space Flight Center.

The speakers that follow me represent some of these major areas and they will provide many of the details concerning Tiros I itself.

(Editor's Note: At this point, a film on Tiros I was shown.)

PROCESSING PROJECT TIROS PHOTOGRAPHY

SPEAKER: CHARLES COLEMAN, ASSISTANT CHIEF ENGINEER, NAVAL PHOTOGRAPHIC INTERPRETATION CENTER

IN HANDLING the Tiros photography the Navy had four basic tasks: first, just to process the material—get it out in the requisite number of copies; second, to see what could be done to utilize the photography to correct the position and verify the position of the satellite in orbit; third, to work on the problem of what kind of presentation could be used best by the meteorologists; and fourth, to assist any interpretation techniques that might evolve.

Under the general coordination of Dr. Charles C. Bates there were two Naval agencies involved in this, the Naval Photographic Interpretation Center and the Naval Photographic Center, working together as a team under the Bureau of Weapons.

Figure 1 on page 26 shows the series of chronological steps performed in the photographic handling of the Tiros photography. The major thing to note is not the individual steps so much as the fact that there are two principal outputs here. One is the development of material in final form for the meteorologists, and, when you consider the number of photographs that have been mentioned, the problem of what to do with stacks and stacks of prints if you make them this way; also, how the meteorologist will know exactly at what he is looking in a cloud-filled picture. The second output is the data that I mentioned in correction of the orbit.

As an indication of the amount of film that is handled, there are about 21 copies of all the material that comes in which are sent out for the various users, meteorological and electronic, in the Air Force, Weather Bureau, Navy and so on.

The problem of photogrammetry in this instance is simply the principle of

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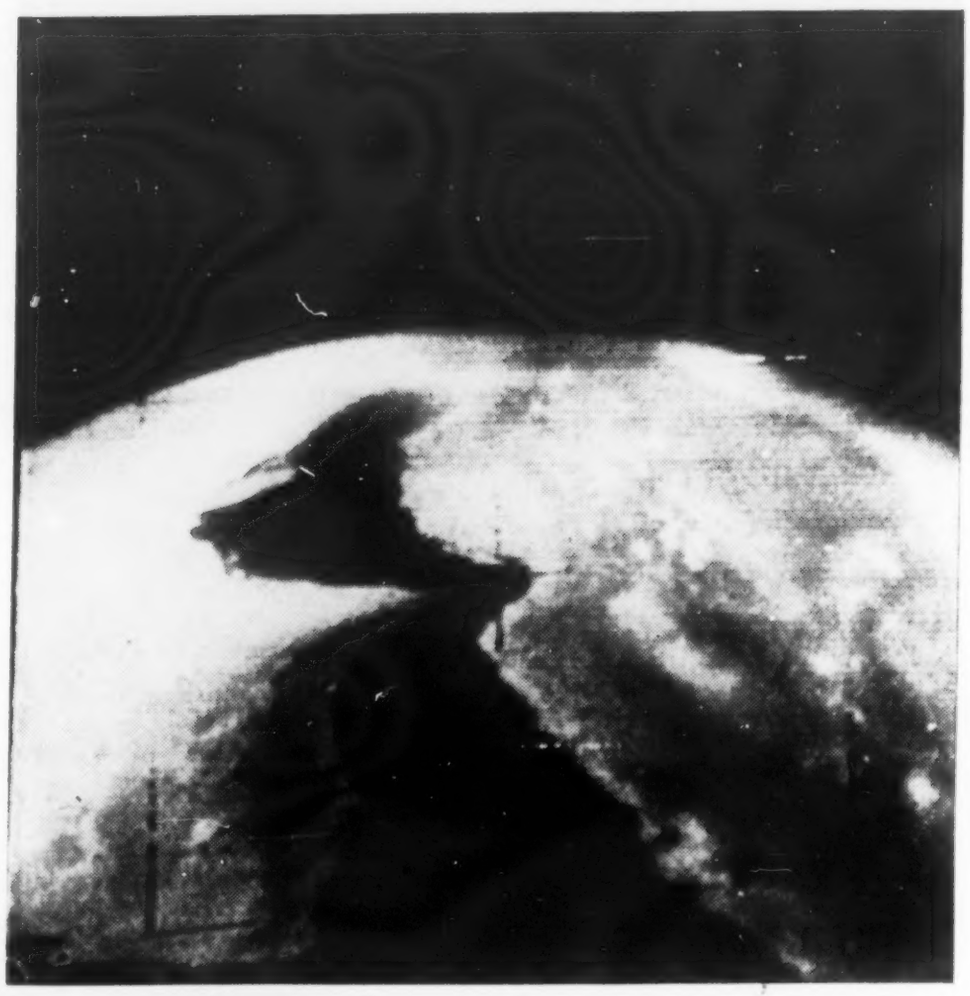
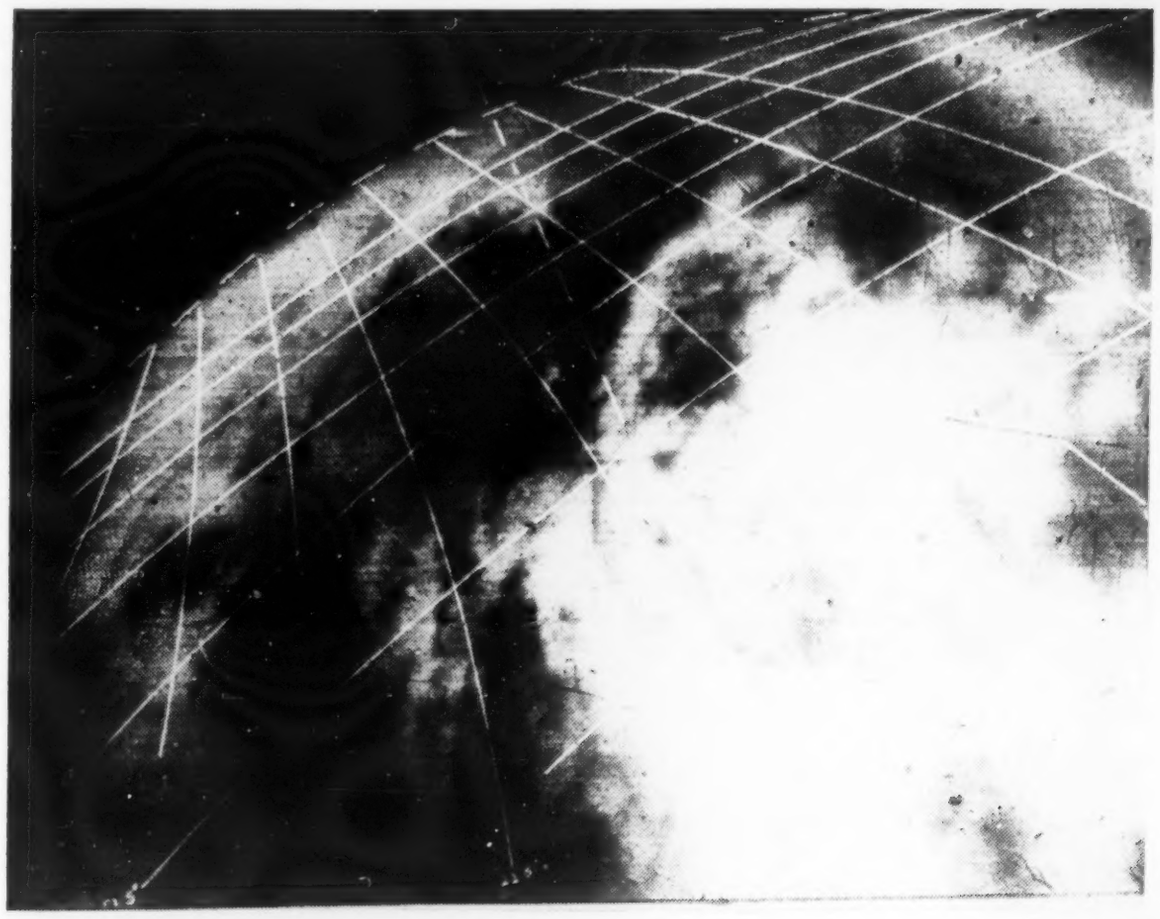
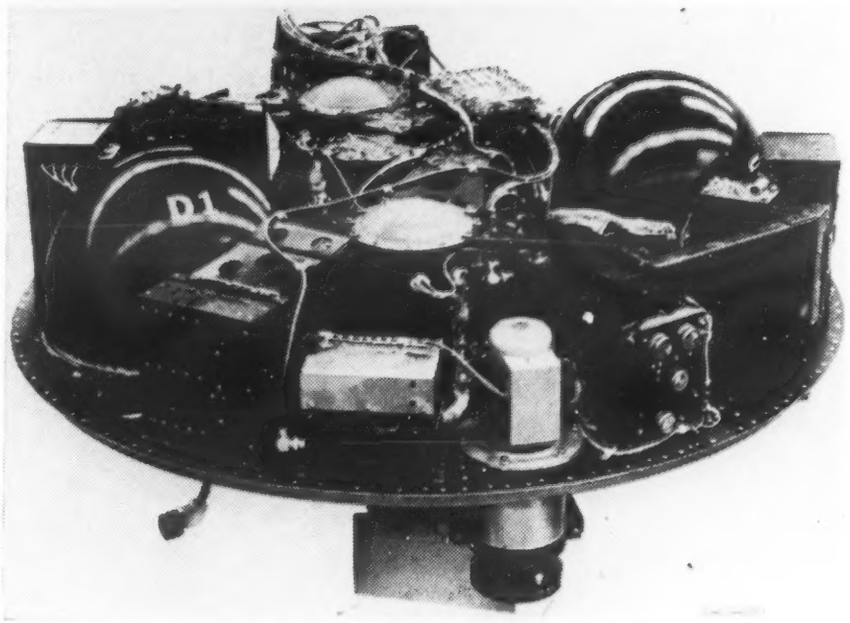
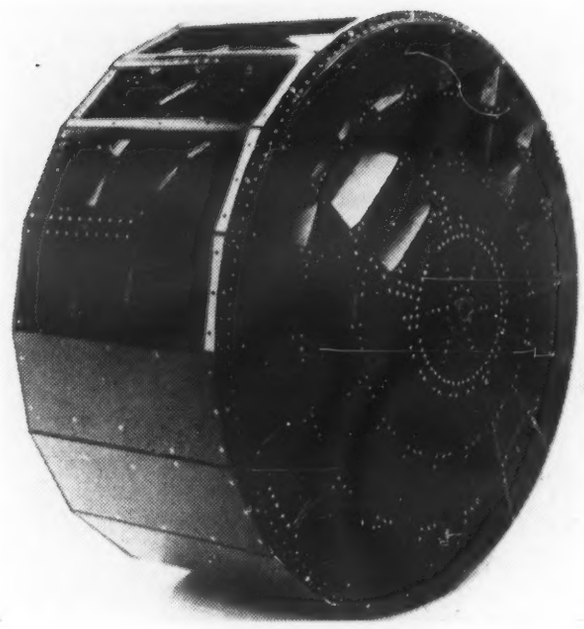




From Mr. Coleman's panel presentation on "Processing Project Tiros Photography" Figure 1 (upper left) shows steps taken in handling Tiros photography. Figure 2 (upper right) shows Tiros view of Persian Gulf area looking northwest. Figure 3 (left) is a demonstration model showing a gridded Tiros photograph. Figure 4, from Mr. Cline's presentation on "Meteorological Aspects of Project Tiros," shows 2 tape recorders inside Tiros.





View of the underside or base plate of the Tiros satellite.

—I guess it was Archimedes who said, "Give me a place to stand and I'll move the earth"—in reverse, we are not attempting to move the earth, we are attempting to find out where it is. And while there is a considerable amount of electronics devoted to this, the very need and entirely separate verification of this comes from a study of the photographs themselves. By knowing the position of the land masses and by computing backward to the position of the satellite, one can develop this information.

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After the points are selected they are measured, and here again we utilize some precise optical equipment. The photographs are enlarged up to 20 to 40 times, projected down at a co-ordinated graph reader which reads directly into the electronic card and tape-punching device utilized, and as many control points as possible are selected —anywhere from 6 to 9 per frame.

The computation is done by the Weather Bureau IBM 704, developing this in collaboration with the Goddard Computation Center, and the piece of equipment, which actually is not functioning yet, will take direct output from the computer at the Weather Bureau and draw a grid. A vertical optical printer is used to marry the annotation to the original photograph. Duplicates of this new photograph are then distributed to the meteorologists for study.

Figure 3 on page 26 is a test demonstration model, but you see at the top a Tiros photo which has been gridded. The imposition of this grid developed from the computation and married in the optical printer provides the meteorologist with the ability to locate where he is on the photograph. This is a very hastily drawn and rough grid and will look much better when it is done by the equipment (which is not yet operating).

Much more remains to be done. As cloud photographs continue to be obtained, an effective automatic sorting and filing system for master negative frames will be required. The work of improving the techniques for locating and rectifying pictures from space vehicles must also continue. Also, many techniques for interpretation of the resulting images must be further refined and developed. However, in the presently adopted system, the basic photographic and photographic interpretation problems of Tiros I have been successfully solved.

The science of rocketry, and the science of electronics, have joined forces in the present space age, to launch and successfully orbit a number of scientific space vehicles. It might be suggested that the support of a third branch of applied science is also necessary for effective space exploration. This is the science of image recording and analysis, which must provide the "eyes" for many of man's probes into space. In addition to its other accomplishments, Tiros I may be memorable as the first satellite in which the talents of the rocket designer, the electronics engineer, and the photo-analyst were combined to provide the scientific data required in the form needed by the user. The user in this case was, of course, that most important man, the meteorologist.

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METEOROLOGICAL ASPECTS OF PROJECT TIROS

SPEAKER: DUDLEY CLINE, DEPUTY CHIEF, ASTRO INSTRUMENTATION BRANCH, COMMUNICATIONS DEPT., USASRDL

INSIDE the Tiros satellite we have the two tape recorders: one for a narrow-angle camera system and one for a wide-angle camera system, fig. 4, page 26. There is complete redundancy in these two systems: they have their own receivers, their own tape recorders. These recorders have 400 feet of $^3/_8$ inch tape on them and run at about 50 inches per second; thus, we have about 100 seconds of tape information on each recorder. Also, there are two separate clocks which are utilized in order to program the events in advance. Since Tiros doesn't look at the earth at all times, and it may not be in daylight, we may say perhaps 30 minutes after we pass a ground station we would like to take some pictures. The clock is then set up on the basis of requiring some 9000 pulses to fill it up. If we put 8000 pulses in on the ground at the time it comes over the ground station, then Tiros will have to fill in a thousand pulses at two seconds a pulse, and it will then turn on the alarm after it has filled up the clock. In the center of Tiros are nickel-cadmium batteries, seven batteries at 1.6 volts to a pack and nine of these packs. A pack of five on which is stacked a pack of four, gives us the 32 volts and 13 volts required to operate the electronics. On the left-hand side of Figure 4 is the horizon-scanner which gives us the attitude data. The other components, of course, are the tape recorders and the command receivers.

The Ground Station

Prior to a pass there are certain pieces of information that are necessary in order to set the ground station up. Primarily, at the ground station we're interested in the azimuth and elevation data. This azimuth and elevation data is fed into the computer, and enables the antenna to be slave to the information. Additional information is also received from the computation center concerning the mode of operation of the program itself; in other words, a normal program might, as Tiros comes up over the horizon, be required to take some direct pictures. Then when it comes to a point where we wish to read out the camera data that has been stored on the tapes, it commands Tiros to do this. After this is completed in some three minutes or so, we then have some additional time, since the pass may be about twelve minutes long, to do some more direct read-out of pictures. There is a series of clocks which enables us on the first command to set up the time that we want direct read-out pictures to start, then we have a second column of controls which enables us to set up the time that we want playback to start. A third device enables us to set up the time that we want to set in the clock pulses, or actually start the clock pulses. By this means we have a completely automatic mode of operation; it is also possible to operate the equipment in a manual mode of operation where you press the button instead of depending on the clock system to start the whole operation. There is a completely manual mode of operation where the operator may press buttons at his own whim when there is a special program set up which requires this mode of operation. Normally, however, the mode is to have completely automatic operation by setting up the clocks.

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(*Continued on page* 30)

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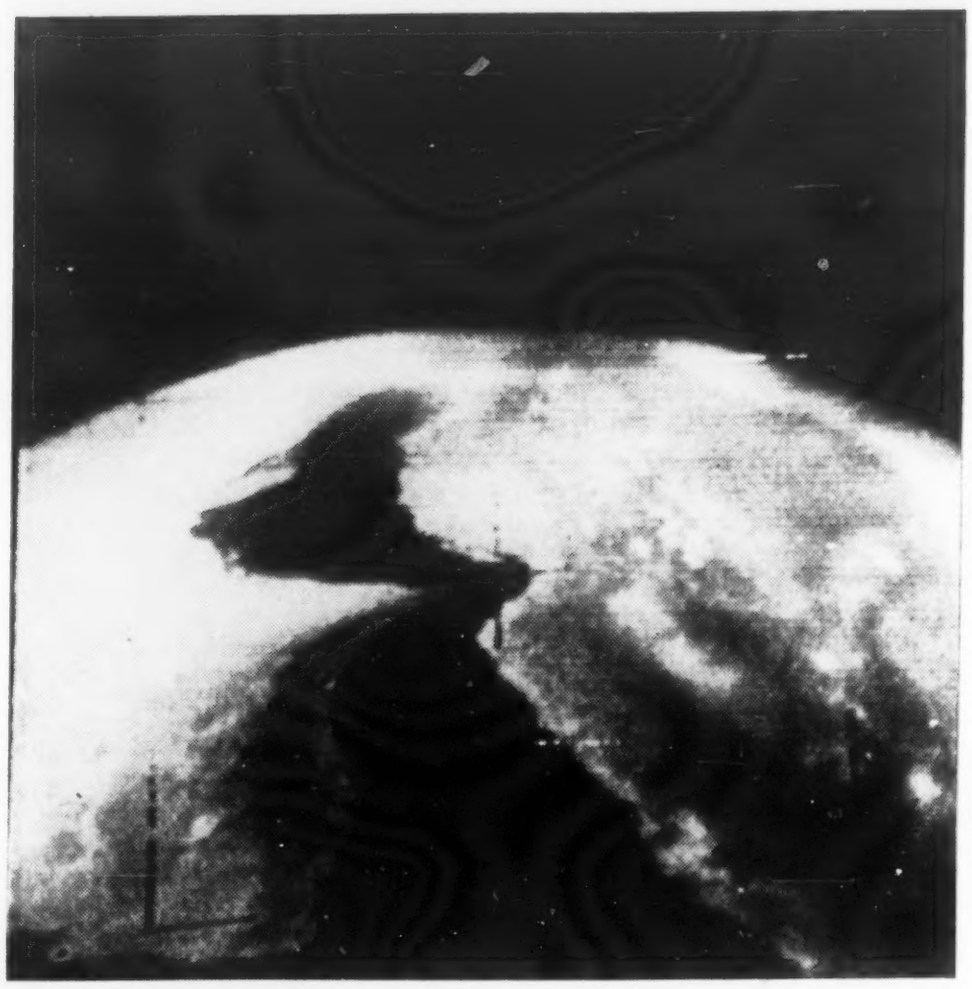

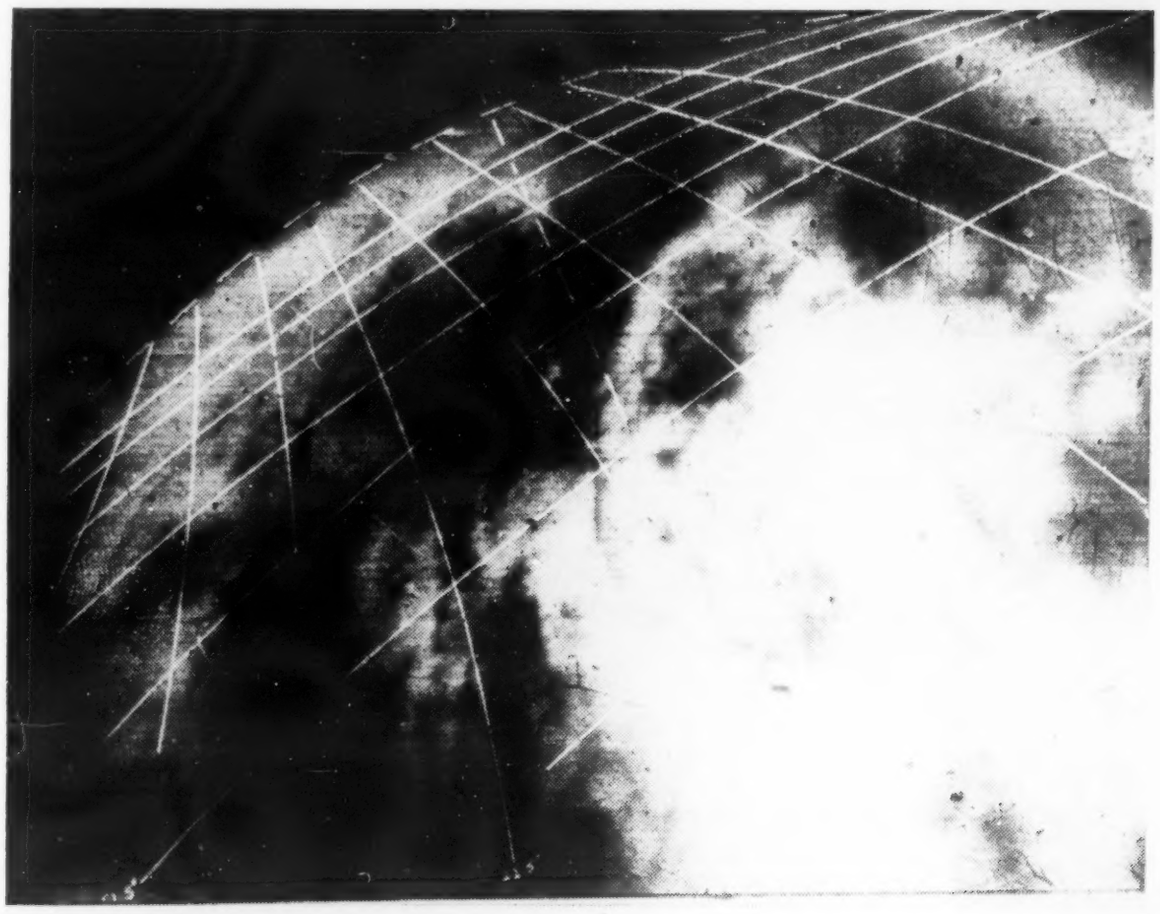

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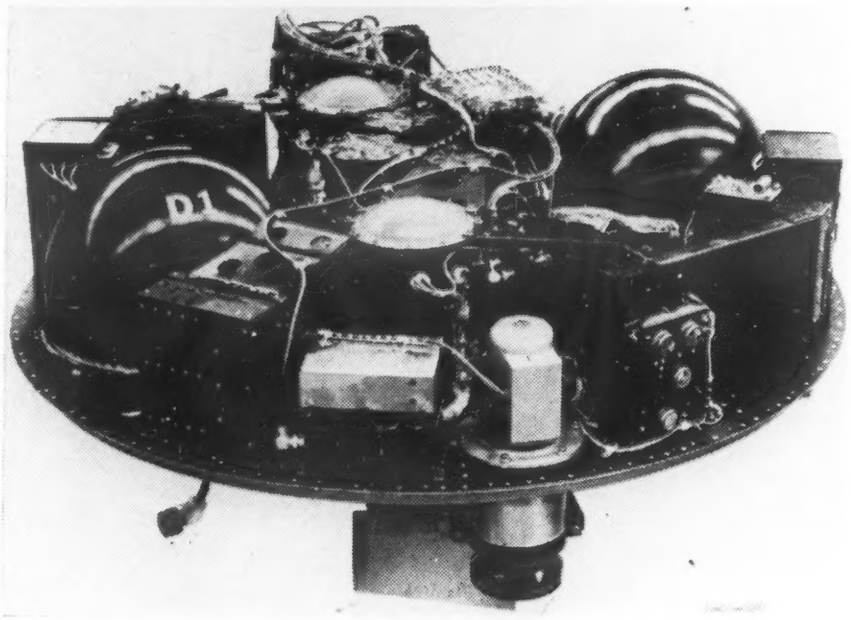

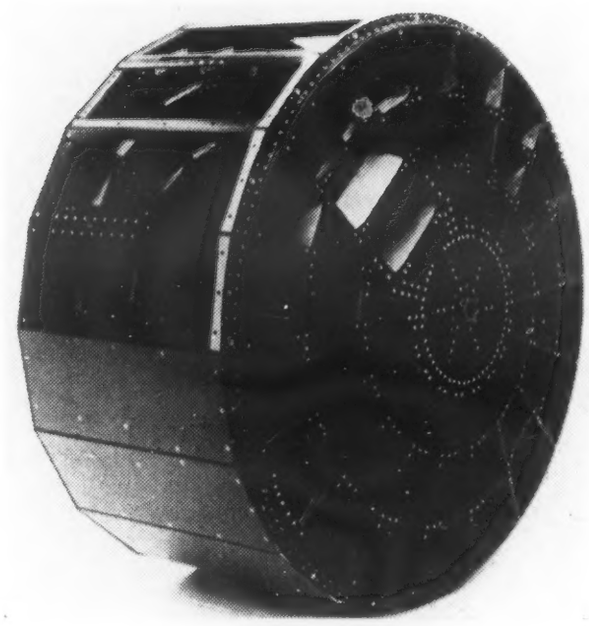

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"Mein Herr, jawohl, durch...

$$\psi(x) = \frac{1}{\sigma(2\pi)^{1/2}} \exp\left(-\frac{1}{2}\frac{x^2}{\sigma^2}\right)..."$$

"El próximo año

$$P = \frac{A}{A\text{-}B} E_{N,A} - \frac{B}{A\text{-}B} E_{N,B}..."$$

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Each of ITT's 101 plants and laboratories (a total of 136,000 em-s ployes) is, by the nature of ITT's farflung organization, a meeting y place for the scientific minds of the world. Ideas pour in, rub shoul-s ders, take off, result in: a fully automated post office in Providence, a R. I. . . ., a multiplier tube that detected water vapor on Venus . . . a C

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"S'il vous plaît...

$$H(x)=\sum_{i}^{n} p_i \log \frac{1}{p_i} = -\sum_{i}^{n} p_i \log p_i \ldots"$$

"Thank you, gentlemen.
Your experience in
your countries has been
of infinite value to us.
In a few years, I think fully
automated post offices are going
to be as American as apple π."

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00 em-satellite system that could make worldwide TV a matter of a few
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according to this slave mode of operation; then, when the first command goes out and the first alarm goes off, the 235 megacycle signal is turned on and this dish tracks at 235 and not at the 108. The 108 is on all the time in Tiros, but the 235 only comes on upon command.

In the 108 megacycle receiver group there are two 108 signals, 108 and 10803, and they are connected and diversely receptioned. We have two receivers for the 108. In the pod of the antenna we have a tape tone converter which brings the signal down to 14 megacycles, and these are just standard 390 receivers.

Attitude data from the infrared sensor is put on the 108 megacycle signal as 3 kc bursts—a series of pulses about 100 microseconds wide. They are received and put on a recorder which gives us the attitude tape in a coded form; this is then printed out on teletype. Actually, there's no time information here, so this is a manual operation. At the time that we get the one-second pulses, the operator notes the time and then the signal is received. The rotational period for Tiros is about six seconds. So far the rotation has kept pretty much to the 10 rpm that it started out with, and spin-up rockets haven't been necessary.

The attitude recorder with the punch tape is nothing more than an elapsed-time computer—a transistorized elapsed-time computer. It determines the time between the attitude pulses that come down to the ground, puts them on the punch tape, and then sends this information to the control center and to the computation center to help in the determination of the attitude of Tiros.

The telemetry information comes down on the 108 megacycle signals, and actually is switched. There is a commutator in Tiros which switches 40 different points of telemetry. This is put on as an FM sub-carrier at 1300 cycles which is modulated from 1200 to 1400 cycles with the telemetry information. The information comes down, is received and recorded on the Sanborn recorder, then these charts are analyzed after the flight is over.

The calibrator is a piece of test equipment that is utilized to line up the camera. In other words, it is a step generator with various shades of gray that we can put on the camera itself. This is a similar situation to your home TV set; in other words, if you don't set the contrast and brightness controls correctly, your picture has very little meaning, and the same thing is true here, only more so. You have to use a calibrating signal to set up the monitor scope with the correct shades of gray so that the eventual cloud pictures will have significant meaning. This calibrator will enable this to be done prior to the pass. Also, there is a counter which counts the pulses which go out to the Tiros' clock, to make certain that what we set into the counter is what goes out—since timing is of utmost importance. This enables the analysis that takes place later on to be determined, to make sure it is known exactly where pictures are being taken.

The 235 megacycle Nems-Clark receivers and two others are utilized for TV information. Two more receivers are just for spares; they were meant for the IR package. They are connected and diversely receptioned. A fifth receiver is another spare, so that in case of a malfunction you can quickly switch from one set of receivers to another. The system modulation is an FM system, with an 85 kc sub-carrier, and black information at 100 kc. There is a deviation of plus or minus 15 kc, and white information is down at 70 kc.

The slow-scan high-persistence monitor is where the pictures come out; as they come out of the demodulator, out of the receiver and into a demodulator, the sweep information is fed to this monitor scope. A 35 millimeter camera system photographs the pictures, and sends this primary data to the Naval Photographic Interpretation Center for processing. There is also a monitor scope for monitoring the line-scan; as the information comes down from Tiros you can view this scope. When you see a lot of wiggles it indicates that Tiros is just looking out at empty space—but when you see that this line-scan indicates lots of wiggles and jiggles, you know you are getting some good cloud pictures and pictures of the ground, too.

On each picture there is some index information indicating the frame that is being taken whether it is a direct camera picture, whether it is a remote picture, the number of the picture, what orbit it is, and so on. In addition, the sun angle data (we have coded sun information around the surface of Tiros in order to determine the position of north) comes down, goes into a computer, and the information concerning the north position is put on the film and on the tape as digital information, in a binary coded form.

The Ampex tape recorders are four-channel tape recorders. Only three of the channels are being used for the primary information that comes down from Tiros. The index information is put on this tape and the sun angle information is also put on the tape so that it serves as a back-up for one thing and also allows the tapes to be played back into the monitor camera system after the pass is over and as many film strips to be made as desired. Normally, after the pass, a positive transparency is made by flipping the signal from the grid of the kinescope to the cathode and making a positive transparency, which then goes down to the meteorological team on site for an immediate analysis and real time weather evaluation.

Another piece of equipment, and probably the most important, is just a simple twenty-channel recorder, an on-off type of recorder. This records the switching that has taken place. It enables you to go back and see if somebody goofed. Basically, you see the events that took place; if you set up a certain program for direct camera readouts to occur at a certain time, you can see whether or not the switching actually took place, the number of shutter pulses that actually went off, the number of pictures that were taken, and things of this nature. Thus, it is a very important piece of equipment in the total analysis of the program effort.

Of course, after the pass, as I said, the positive transparencies are made and the film developed. This provides the information which the meteorologist will analyze.

As of the 23rd of May, there were a total of 748 passes, and at Fort Monmouth we had received some 13,000 pictures to date, and Kaena Point, Hawaii, must have received some seven or eight thousand, so that there are better than 20,000 pictures to date. The temperatures have ranged from a maximum of about 26 degrees—base plate temperatures, that is—and down to a minimum of about minus 9.9 degrees.

Tiros seems to have a self-healing feature. As some of you recall, a few days after the launch, the narrow-angle recording system went out—not the recording system, actually, but the clock. We were, however, incapable of taking narrow-angle pictures any longer, not remotely. About a week or so ago, the boys were playing around—reducing the modulation and reducing power—and suddenly the narrow-angle playback capability came back. We are again taking both wide-angle and narrow-angle pictures on remote.

At one time the attitude data went out; instead of getting pulses we were getting continuous 3 kc information without any pulses. This seems to have healed itself, so Tiros seems to have a self-healing feature that was never intended, but it is very nice to have such a feature in a satellite when you can't go up and make repairs.

In conclusion, I'd like to mention another thing that's important in every satellite design: that is the problem of reliability, and, of course, engineers go all out to build reliability into a satellite. One of the important factors is to utilize tried and proven components. Use something that you know has worked before and you've got a much better chance of reliability. The technique that was used in the preliminary design of Tiros was that of a Brownie camera. This eventually evolved into the final Tiros satellite model.

(Editor's Note: After transmitting 22,952 picture frames since it was launched April 1, 1960, Tiros I ended its operational life June 29, 1960. Scientists believe an inoperative relay in the wide-angle camera system is the probable cause of Tiros' difficulty. The malfunction made it impossible for the camera to turn off. This apparently drained the batteries and eventually caused the wide-angle camera transmitter to burn out.)

Panel II
Industry Reports

BY GENERAL ELECTRIC COMPANY

MODERATOR—RICHARD SHETLER, GE. INTRODUCED BY THOMAS B. JACOCKS, GE

SUPERCONDUCTIVITY

SPEAKER: LLOYD HARRIOTT, MANAGER, ELECTRICAL ENGINEERING LABORATORY, GE

CRYOGENICS is the name given to the study of many strange phenomena which occur at low temperatures in the vicinity of absolute zero. I'm going to talk to you this afternoon about only one of these phenomena, the one called superconductivity, or the complete absence of electrical resistivity in this temperature range. Superconductivity is not a new phenomena—it was discovered in 1911 by a Dutch scientist named Onnes, in doing low-temperature work with mercury.

There has been considerable scientific effort during the last 50 years to understand and explain the phenomena of superconductivity, but it has remained almost completely a laboratory curiosity until relatively recently. This was due in great measure to the high cost of refrigeration necessary to produce the very low temperatures in which the phenomena takes place. In the last few years the stress on getting low temperatures, especially for applications to missiles and other defense projects, has produced engineering developments which have made the reaching of low temperatures considerably more economical. As a result, what has been just a scientific curiosity may, within a very short time, become very important in the engineering area for both defense and industrial applications.

The basic concept of superconductivity is the relation between electrical resistivity and temperature. In most conductors, resistance continues to decrease as the temperature goes down and approaches, but never really reaches, zero as the temperature approaches absolute zero. There are some materials, however, called superconductors in which, at a critical temperature, the resistance suddenly disappears; that is, at least within the accuracy of scientific measurements, electrical resistivity below this critical temperature is zero. There are about 20 metals which show this phenomena—mercury, lead, tantalum, niobium and tin being examples. There are also an unknown number of alloys and compounds which exhibit the same properties. Strangely enough, those materials which are the best conductors at room temperature, like copper, silver and gold, do not become superconductors. Each superconductor has its own critical temperature at which its resistivity disappears, but since the highest that is known today is somewhere around 18° Kelvin, we can look at superconductivity as a phenomenon that occurs essentially very close to absolute zero. The most common method used to obtain these temperatures is to submerge the material in liquid helium, which boils at 4.2° Kelvin at atmospheric pressure.

The simplest manifestation of the superconducting effect is that of the persistent current, or the current which will flow forever. Take, for example, a ring of superconducting material in which I have assumed that by some means or other I have established a current. The electrical engineer would describe the performance of this circuit by an equation which says that the rate of change of magnetic flux established by the current was equal to the negative of the resistance drop. For most common conductors, the resistance of the loop would be finite and the flux would decay exponentially. However, since this loop is made up of a superconductor, the resistance is zero. Therefore, the right hand side of the equation is zero, and the time rate of change of flux must be zero. This means that the magnetic flux, once established, would remain constant forever. Now, if the physical environment around the loop also is not changed, the current is proportional to the flux and the current would also remain constant forever. Experiments of this kind have been run for several years, and no measurable change in the current has occurred. This means that truly, at superconducting conditions, the electrical resistivity of superconductors seems to be zero.

Magnetic Insulators

An interesting corollary of the persistent current phenomena is that superconductors are also perfect magnetic insulators. If we consider any solid superconducting surface, we can think of it as an interconnected set of superconducting rings. Since the magnetic flux through any one of these rings cannot change, the magnetic flux through the entire surface cannot change. This means that should we by any method try to establish a penetration of magnetic flux through the surface, eddy currents would build up in the material as they do in conventional conductors to oppose this change of flux. But since the material is superconducting, these eddy currents do not decay but would remain at exactly the value needed to completely prevent the penetration of the flux.

It would seem at first glance that we have found a way with superconductivity to carry infinitely large currents in infinitely small wires with no losses. This, of course, is not true. Nature places limits on most every phenomena, and there is a limit on the current which a superconducting circuit can carry and remain superconducting. The limit, however, is not in terms of the current density or the amperes carried per square inch of cross-section of the conductor, but rather is in terms of the magnetic field which that current establishes at the surface of the conductor. This effect is called the critical magnetic field effect and is a function of temperature. For niobium, for instance, superconductivity occurs at approximately 8° Kelvin in the presence of little or no magnetic field. However, even the slightest current flowing in a niobium wire at 8° Kelvin will force it to turn nonsuperconducting or resistive. If, however, we were to lower the temperature to something closer to 4° Kelvin, enough current can flow to produce a magnetic field of approximately a thousand gauss before resistance again appears. As the temperature approaches absolute zero, the critical field which the conductor can stand, or the current which the conductor can carry and still remain superconductive, goes up. Again, the critical field which a conductor can stand is the property of the conductor itself. For niobium, this field approaches approximately 2000 gauss as we get close to absolute zero, while for lead, it never goes above a few hundred gauss. It makes no essential difference whether this magnetic field at the surface of the conductor is

established by some external magnetic circuit or by the current flowing in the conductor itself. It is the absolute value of the total field and not even its direction that seems to matter as far as whether the material is superconductive or resistive. This existence of a critical magnetic field certainly places a limitation on the phenomena of superconductivity but it also makes possible some devices which could not be built if the phenomenon were not there.

One use of the superconductive phenomena, and especially of this critical magnetic field phenomena, is the cryotron switch. This switch consists of two wires, one wound around the other. With this switch, the central or gate wire is made of a material with a rather low critical field and the surrounding or control wire made out of one with a rather high critical field. With no control current flowing, the central wire is superconducting and therefore has no resistance. If we put a sufficient current through the control wire, we can make the magnetic field at the surface of the gate wire be above the critical value, while the field at the surface of the control wire is not above its critical value. This means that the gate wire will become resistive while the control wire remains superconductive. Thus, by turning the current on and off in the control wire, the resistance of the gate wire changes from zero to some finite value. It is true that the finite resistance is very low, but the switch is still very good because its closed resistance is zero and thus the ratio of on-to-off resistance is infinite.

This basic cryotron element can be the foundation of a new kind of digital computing circuitry. Cryotrons are not made, in general, today by winding one wire around another but are made of thin films. I do not have the time to explain the operation in detail, but briefly, by applying currents to various windings in turn, I can cause the current to "flip" from the top to the bottom circuit or vice-versa. With this relatively simple circuit, then, I can achieve the basic flip-flop function which is one of the basic building blocks of the digital computer. This circuit can be used to drive a succeeding flip-flop and thus proceed to build a shift register, or a counter, or most any other conventional digital logic circuit. A large array of such cryotron elements could conceivably comprise an entire digital computer working under superconductive conditions.

Quite a different application of the superconducting properties are their use to provide forces and to build a simple bearing. A current flowing in the ring, will establish a magnetic flux. A disc of superconductor can be pushed down toward the superconducting ring imbedded in the iron. Since superconductors are magnetic insulators, all of the magnetic flux is forced to flow between the superconducting ring on the bottom and the superconducting plate on the top. As the plate is pushed down decreasing the distance delta, the magnetic flux lines are concentrated or crowded. Thus, the flux density goes up and a magnetic force of increasing value pushes up against the plate. Thus, I have a simple bearing or spring. The harder I push down, the closer the two plates get together but the harder the magnetic circuit pushe-back to establish an equilibrium. As I try to decrease the distance delta to zero, the force tries to go to infinity, but eventually the point is reached where the critical magnetic field is exceeded, the materials become nonsuperconducting, and the force can no longer increase. But within this value, that is, before the critical magnetic field is passed, the bearing is a perfectly elastic spring which will hold physical forces. Most of all, since the plate has no resistance, there would be essentially no electrical losses on rotation of the shaft.

This bearing principle is being used to develop a new kind of gyroscope known as the Cryogenic Gyro. The rotor is a sphere made of superconducting material, or at least with a superconducting surface. This sphere is completely enclosed in a spherical housing made of iron, with a number of superconducting coils to support the bottom, to push down from the top and to push in around the side. Proper distribution of these coils will provide balanced forces in the three primary directions upon the rotor and thus completely suspend the rotor on elastic, magnetic, lossless bearings within a spherical cavity. If the space between the spherical rotor and its spherical enclosure is evacuated and then the rotor is spun, it can be supported in space on completely lossless bearings and therefore should spin forever, or at least for a very long time.

The rotor is spun by a superconducting motor. The very same principles that make the bearings possible also make this motor work. The cuts located around the equator of the sphere act essentially like the salient poles in a synchronous machine. By producing a revolving magnetic field which starts at very low frequencies and gradually builds up, this rotor is dragged around and brought up to speed. Again, there are no electrical losses in the spherical rotor.

As long, then, as this rotor remains superconducting, the rotating mass is spinning on essentially frictionless bearings and is subject to no arbitrary external torques. This is about as close as one can come to the definition of a theoretically perfect gyroscope. Indeed we do expect by the use of these principles of superconductivity to produce a gyroscope which has higher accuracy, higher reliability, and which will maintain its accuracy for longer periods of time than any gyroscopes produced by conventional techniques today. The bearing principle and the motor principle described here have already been shown in practice, and a simple model of the gyro based on these principles is now under construction.

What then are likely to be the engineering implications of the use of this phenomena, superconductivity? I spoke previously of the ability to build digital computer elements; namely, the cryotrons. Present indications are that large arrays of these elements can be built by some mass production fabrication technique, perhaps similar to that which is now used to produce printed circuitry. Such an approach should give the ability to build very large computers at reasonable cost. The cryotron elements themselves can be made very small. Therefore, it should be possible to pack into a relatively small volume a computer of rather large capacity information-wise. Since the elements themselves are lossless except during the actual switching time, such a cryotron computer would have an exceedingly small power drain. An estimate has been made that a computer consisting of a million cryotrons might require something less than a watt to run it. Cryotrons do not appear to be extremely high-speed devices. However, speeds of operation competitive with other techniques known today, can most likely be achieved. Therefore, it is quite possible that cryotrons will present the opportunity to build very large computers which are microminiature in nature, which have very low power drain and which should be economically attractive. Cryotron computers also have the potential of being extremely reliable because the only element that appears to be needed in them is the basic cryotron itself. Once made and put into liquid helium, which is about the most inert atmosphere known, there is little to indicate that such an element should fail in use.

If such computers of large capacity, small size and low power drain with inherently good reliability should become available in the near future, they would of course be immediately useful to the military for a great many applications. They should also be attractive in the future for commercial applications because in the commercial field of data processing, the stress for handling more and more information in smaller and smaller units with increased reliability and reasonable cost is also great.

I spoke also of the potential of building a superaccurate gyroscope using cryogenics. The same principles that would make this gyro practical would also make possible an accelerometer with zero friction bearings. The threshold—that is, the minimum acceleration which can be measured—should approach zero, and linearity should be maintained over a wide range of acceleration measurements. If we put together the cryogenic gyroscope, a cryogenic accelerometer and add to it a cryogenic digital computer a complete cryogenic navigation system is possible. Such a system has the potential of offering to the inertial navigation field increased accuracies, increased reliabilities, longer life because of no mechanical wear, and probably greatly reduced size and weight.

In addition to these two specific applications which I have mentioned it is also possible to think of developing special amplifiers using cryogenics—amplifiers which could have zero d-c drift, and very low noise levels. The persistent current effect of cryogenics could make possible current standards of accuracies unknown today and ones which will hold their accuracies over indefinite periods of time. Although superconductivity does not really exist at higher frequencies, superconductors still have lower surface resistances at reasonably high frequencies than do most normal conductors even at the same temperatures. This fact might make possible building of radio frequency circuitry of extremely low loss, low noise level, and extremely high Q's. It is even possible that in the very distant future the superconducting circuits might be used to carry high currents for power purposes. A simple calculation will show that a relatively small conductor is all that is needed to carry many thousands of amperes, and in fact, since the current that it can carry is limited not by the area of the conductor but by the periphery which determines the magnetic field, a very thin skin of conductor wound around an insulator could carry the currents normally carried in power circuitry. The application to power circuitry, of course, is not economical at the present time, but this is no reason to believe that in the distant future the economic factors might not change.

The one problem in superconductivity of which I'm sure all of you are thinking and about which I have spent very little time is that of refrigeration or obtaining the low temperatures. Today, this is a costly process requiring machines of relatively large size, and in many cases may completely outweigh the reductions in size and weight that can be obtained by using cryogenic components. There are developments going on in this field, too, and it appears very reasonable to assume that in a matter of a few years devices for liquefying helium and for supplying it in the kind of quantities that would be needed for cryogenic computers or navigation systems can be made smaller and lighter by perhaps an order of magnitude than those that are available today.

It is probably not possible at this early date to predict what the real impact of cryogenics is going to be on the electrical industry. However, since the phenomena of superconductivity is so broad and fundamental to the whole field of electrical engineering, cryogenics seems almost certain to have a significant effect on the future development of the electronics industry.

NEW HORIZONS IN POINT-TO-POINT COMMUNICATIONS

SPEAKER: ALBERT WILD, MANAGER, MILITARY SALES, COMMUNICATIONS PRODUCTS DEPT., GE

THE NEW HORIZONS opened for us by space exploration and satellite communications are tremendous—the previous two days' speeches here, I am sure, have opened the eyes of all of us to the great opportunities which lie ahead. There is another kind of horizon, however, one less spectacular because it is more familiar, but every bit as important. This is the horizon of technique improvement, of better components and equipments, for our more familiar, older communications techniques. It is this area of new development that I want to talk about today.

The area of space and satellite communications has been highlighted for the past two days by outstanding experts. Therefore, I am deliberately omitting discussion of our company's activities in these fields, and instead will bring you information on some new tools which have been developed in General Electric's "Communications Central" in Lynchburg, Virginia.

Four Essential Elements in Communications

Any communications system always contains four essential elements and all work in communications systems may be separated into these elements. They are:

1. Input and Output Devices
2. Terminal Equipment
3. Switching Equipment
4. Transmission Media

All are equally important—all deserve considerable attention—and our communications depends on continual advances in techniques in all four elements.

I want to tell you about four exciting new products on which we are working which cover most of the communications spectrum. These products are not related to each other necessarily, but they are always related to the elements mentioned. I feel sure you will find among them something that can help you in your work.

New Equipment

The products are DISCOM and a new light valve projector, which are examples of input and output devices; a new transistorized multiplex equipment, which is an example of terminal equipment; and a new single sideband tropo scatter system, which is an example of a new transmission media equipment.

DISCOM, short for DIgital Selective COMmunications, is a new digitalized input and output device known officially as AN/URA-22 and AN/URA-29.

DISCOM is air/ground/air digital terminal equipment which offers push button communications for canned or "book" messages and also message composition capability. The device operates over any voice circuit, and can be used to call any of half a million addresses. The device, using the standard 8-bit fieldata code, is constructed entirely of solid-state items.

DISCOM equipment consists of three small, black panels (Fig. 1 on pg. 37). The left top panel, called the control monitor, contains equipment for addressing messages, for identifying locations from which messages are being received, and for determining the frequency and mode of communications used. At the bottom, a small drawer pulls out when messages are to be composed.

The right-hand panel is the display panel and is used to display incoming messages visually as well as to display locally composed messages which are to be sent. The display is accomplished by small wheels which turn behind windows similarly to the way wheels turn in a conventional mechanical calculating machine. The ground equipment at the other end of the communications circuit has essentially these same elements.

In Figure 1, the three panels are shown in the group at the left of this picture, and the drawer with the handle on it is shown at the lower left-hand corner of this group. When this drawer is pulled out and tilted downward slightly, it displays a group of push buttons, which are illustrated in the enlargement at the right of this picture. Each push button illustrated at the right does two things: when canned messages are being sent, each button represents a word frequently used in most canned messages. Each button has an alpha-numeric character on it and can be used to set up that particular character when individual messages which are not subject to preplanning are to be sent.

Sending the Message

Let's now consider how a typical canned message would be sent: first, the operator sets up the address to which he wishes to send his message by manipulating these knobs and selecting the VHF or UHF equipment he intends to use. The call showing in the left-hand window indicates his last call was from WADD. In this case, he has set up to address his message to Offutt Air Force Base. He then pulls out the drawer and pushes the button marked "clear." Lighted push buttons on the push button panel immediately go out except those in the area which are all

lighted, to indicate that he should select the type of message he wishes to send. If he pushes the one marked "distress," that word appears, and all lights on the push button panel go off except those in the area which come on to indicate further words or groups of words which are pertinent to a distress message. He pushes one or more of these, which immediately cause the corresponding words to appear in the windows and he then fills in additional information, which is usually one or two numbers, to complete this form of message. Thus, by pushing 3 buttons he can send a message like this, "distress—fire—abandon." More routine messages can be similarly composed very rapidly. When the message is fully composed, the operator pushes the button marked "transmit." The message is sent out instantaneously in a short burst of digital pulses, and shortly thereafter the "acknowledgment" button lights up to indicate his message has been received by the addressee.

Now, consider a message which does not have a fixed format and is not capable of being canned. When the operator wishes to send this kind of message he composes it by manipulating the alphanumeric numbers or letters on the buttons. The characters appear one by one in the display windows. The yellow lights indicate to him which line is ready for the insertion of the next character. The row of unlighted buttons across the bottom would, in an actual case, really have one lighted which indicates where, across the horizontal number of characters, his next selection will appear. This procedure is quite rapid—approximately one or two characters a second. When the message is complete the operator pushes the "transmit" button and receives acknowledgment as before.

Unless the operator is composing a message, the last message either sent or received remains displayed here. As a new message comes in addressed to him, it will appear instantaneously, and proper lights so notify him.

If the operator is composing a message, or has just composed one on the panel, and a message for a particular aircraft comes in while he is doing so, the message being received will automatically be displayed and the one being composed is held in storage. After he has noted the incoming message, he can recall his original composition to add to it, change it, and transmit when he is ready.

DISCOM should be considered an adjunct to voice communications for use in routine situations or as the only means of communications under adverse conditions. Adaptations of it are easy to visualize for all kinds of other communication problems with which many of us are concerned. We would like to hear from anyone who would like to consider similar techniques for his problem which can be point-to-point as well as mobile or airborne.

The benefits DISCOM offers over more conventional air to ground communications are: accurate communications when voice is useless and at longer ranges, works through interference and under bad signal to noise conditions—achieved through digitalization, error free capability through visual display, more messages through existing channels, reduction of present delays, simplification of communications functions for the pilot and ground operator, and compatibility with existing facilities.

DISCOM is being developed for Wright Air Development Division of the United States Air Force. The first models will be delivered during 1960. Since this product is undergoing continual refinement, the final product may not be exactly as illustrated here in all respects.

Our light valve projector is an entirely new display device which solves the age-old problem of making a cathode ray tube or TV picture tube large size with full theatre brilliance. It uses principles similar to those to be described by Dr. Glenn in his talk. In fact, much of the developmental work for this was performed by Dr. Glenn. The device can be used in a combat operations center where the personnel are presented with a brilliant, high resolution, and high definition picture, projected from the rear, onto a translucent screen. The personnel face the screen from the opposite side. All of us have seen pictures of plotting rooms where the information was crayoned on from behind by hand, or where it was projected in high brilliance, but with a delay while a photographic film process was developed. Most of us have also seen television big-screen projecting devices which do their work by blowing up a conventional kinescope picture, using Schmidt optics and with disappointingly low light level. Usually the picture must be viewed in almost complete darkness.

Here, for the first time is a means for high brilliance, high definition, instantaneous display of any electronic signal which can be presented on a cathode ray tube. The light for the picture comes from the port. Two such devices have already been shipped to a classified installation by the U. S. Navy.

Let's examine them. Briefly, the way a picture is made is by an electron beam scanning a thin film of highly developed and specialized liquid material resembling viscous lubricating oil. The electron beam impinges on this oil in an evacuated space and causes a pimple-like depression in the surface of the oil. This depression is scanned electronically similar to the way electron beam scanning is done in any kinescope tube. The result is a raster on the surface of the oil which persists for a short time. The picture signal to be presented is fed into this raster. An extremely bright light from an xenon lamp or arc source is focused on the surface of the oil and refracted by the raster. This light is then passed through interference gratings and, by proper use of lenses, may be thrown on a theatre size large screen. Resolution is limited only by the fineness of the beam and the amount of bandwidth available. The amount of magnification desired is strictly a function of how large a screen you want to illuminate. The light level is limited only by the intensity of the illuminating light source and is made bright enough to overcome the room light level. This is practically unlimited, as light sources of tremendous wattage may be employed, depending upon how much light one wishes to show on the screen. For instance, a 2 kw xenon lamp producing 1000 lumens will give you 20 ft.-lamberts on a 10′ x 10′ screen.

Presently, several types of military light valve projectors are being developed. One is a high definition television display projector. Two of these have already been shipped. The development is also well along on a unit that will be fed by a computer and will project alpha-numeric information for situation display.

The light valve projector features movie theatre brightness, movie theatre size, full color or black and white, high resolution, instantaneous display — no processing delays — and is adaptable for 3-D.

Next, I would like to describe the communications element known as Terminal Equipment, and a new product—a new transistorized voice multiplex for wire cable or radio, Model TCS-600, much smaller and requiring much less power than former tubed multiplex equipment.

Transistorization yields large dividends in reliability and space. For example, the equipment in one rack of the TCS-600 handles 12 voice channels. The whole rack would be full if conventional tubed equipment were used. For 600 channels the new TCS-600 MUX uses 11 eight foot racks. This corresponds to 50 racks for conventional tubed equipment.

As mentioned, the TCS-600 transistorized multiplex carries 600 full duplex voice channels; it is fully transistorized and is compatible with CCITT and Western Electric practices. It occupies one-third the space previously needed by multiplex equipment and it uses 10% to 25% the power previously needed. The TCS-600 features unusual reliabilities through having parallel common equipment components. The first quantity use of this new transistorized multiplex will be made by Western Union, who has purchased a substantial quantity for use in their coast-to-coast microwave system now being implemented.

Thus far I have covered samples of input and output devices and terminal equipment. Now for a look at a new transmission media tool, the AN/FRC-47 single sideband tropo scatter equipment which has more than twice the range of any previous tropo scatter

(*Continued on page* 36)

ALDEN SCANNERS MARK NEW ERA IN FACSIMILE COMMUNICATIONS

Compact, mobile Alden Flat Copy Scanners are in use today throughout the U. S. Weather Bureau Hi-Altitude Facsimile Network — marking a bright new era of simplified, continuous facsimile communication. And here are the reasons why —

NEW INSTALLATION SIMPLICITY . . . within two hours of air delivery, Alden Scanners at the Hi-Altitude Network were uncrated from their fold-away shipping cases, rolled in, plugged in, and *fully tested* for 60, 90, and 120 RPM quiet and dependable operation.

NEW COPY HANDLING SIMPLICITY . . . map transmission is no longer dependent on exact drum mounting. With Alden's expandable copy feed head, maps of *any width or length* can be scanned, one after the other, fed straight or crooked, *with only one Alden Scanner.* Original plotted maps can now be scanned without cutting to size. Map plotters have originals returned in half the time. Space and maintenance problems are minimized.

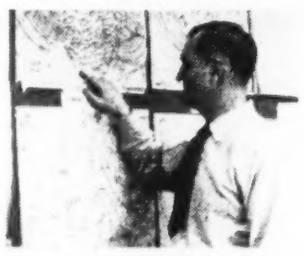
NEW CLARITY — NEW SHARPNESS . . . with copy feed rolls precisely positioning surface of the map on the flat copy scanner table, exact focal lengths are maintained for clear, sharp recordings. Focus smudge caused by unusually thick copy or copy lifting from drum is *completely eliminated.*

MEETS ALL FUTURE REQUIREMENTS . . . the practical scanning equipment for a world-wide facsimile map network. Speeds can be easily increased — without reengineering of equipment — for use with coaxial or microwave transmission facilities and computer-processed weather data.

WHAT ARE YOUR FACSIMILE REQUIREMENTS? LET'S GET TOGETHER . . . Alden Flat Copy Scanners and Recorders are available in all sizes (and up to 30 times present network speed) to users and qualified manufacturers. Your inquiry is invited.

HERE'S WHY FORECASTERS PREFER* ALDEN RECORDERS AND ALFAX MAPS AND WHY WE THINK YOU'LL LIKE THEM TOO!

MOST COMMENDED FEATURES OF ALFAX MAPS



Color Is Easiest To Read Under All Lighting Conditions

Ease Of Writing And Erasing Enhances Analysis

Clean Crisp Duplicates By Bruning Or Ozalid

PLUS THESE UNIQUE FEATURES

LOW COST . . . Alfax papers save 1/3 to 2/3 yearly paper costs.

CLEAN . . . Electricity is the Ink . . . ion deposits make crisp brown marks on clean white background — free from dust, smudge and chemical irritants.

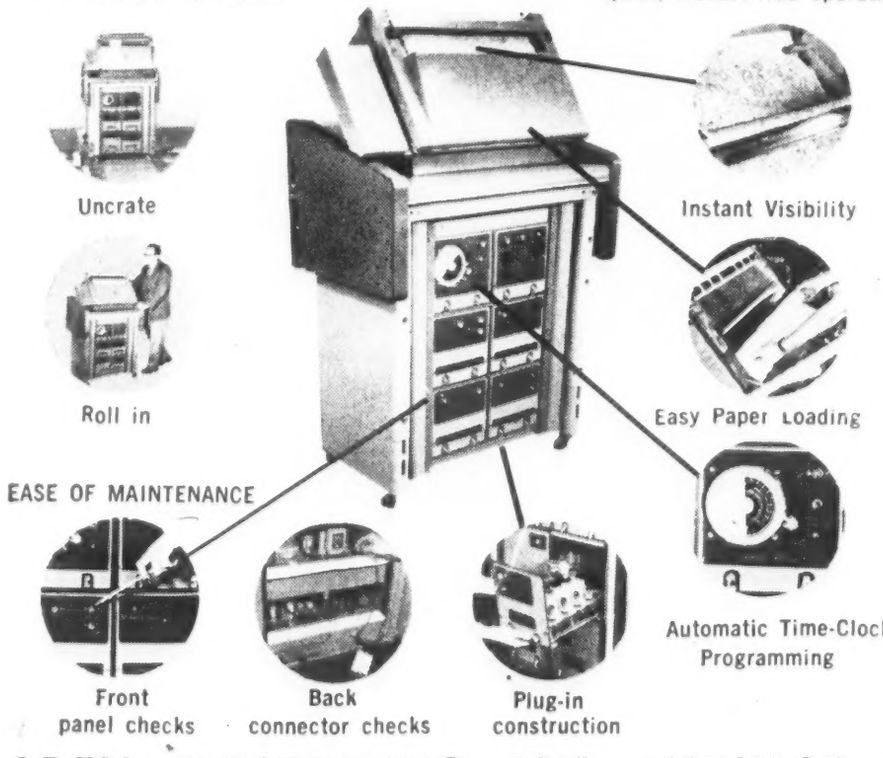
PERMANENCE . . . Alfax stores indefinitely . . . recording marks are permanent.

* In surveys of weather forecasters experienced with all weather facsimile systems, 3 out of 4 indicated a marked preference for Alden Recorders and Alfax Maps.

MOST COMMENDED FEATURES OF ALDEN RECORDERS

EASE OF INSTALLATION
Compact, mobile, and ready for immediate operation.

EASE OF OPERATION
A new high in clean, quiet, trouble-free operation



Uncrate

Instant Visibility

Roll in

Easy Paper Loading

EASE OF MAINTENANCE

Front panel checks

Back connector checks

Plug-in construction

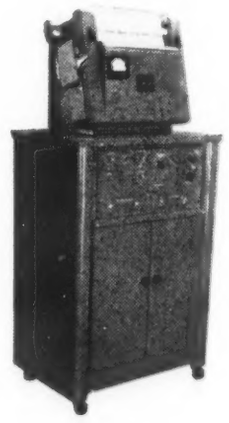
Automatic Time-Clock Programming

PLUS THESE UNIQUE FEATURES

SECURITY . . . Low voltage marking process does not generate a signal that can be intercepted.

HIGH SPEEDS . . . Sixty, 90 or 120 RPM operation — recorder technique and paper capable of 15 times these existing speeds.

VOLUME PRODUCTION . . . Designed for volume production on short lead time through unique expandable manufacturing processes.



CEILOMETER BREAKTHROUGH

Used with rotating beam ceilometer, Alfax paper and Alden recording techniques replace continuous live scope observation with a continuous pictorial history of cloud conditions. Dynamic tone-shade gradients in warm color reveal all pertinent ceiling information in easy-to-read, easy-to-interpret form. Superimposed dark maximum signal marking shows exact reportable cloud height.

ALDEN ELECTRONIC AND IMPULSE RECORDING EQUIPMENT CO., INC.
Alden Research Center **Westboro, Mass.**

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In this talk I have attempted to give you a progress report on only a few of the many items of equipment which have been and are now being developed in General Electric's "Communication Central" at Lynchburg, Virginia.

THERMOPLASTIC RECORDING

SPEAKER: DR. WILLIAM GLENN, GENERAL ELECTRIC RESEARCH LABORATORY

THE LAST FEW SPEAKERS have described a recording system that has very high resolution, does not require any chemical processing, is erasable, and can be reused. You can get color images with this system almost as easily as black-and-white ones, and you can record electrical signals at bandwidths that are well in excess of video bandwidths. To read out the information requires a very simple modification of standard projection equipment. The cost of recording information in this way should be quite low. I will now try to explain to you how this system works and why it has these advantages.

The recording is made in the form of small ripples on the surface of a plastic film. The ripples are formed by means of an electron beam, which scans the surface of the film. The recorder has an electrical input similar to a magnetic tape recorder, and an image output that is similar to photographic film. The latter can be changed to an electrical output signal by standard techniques.

Fig. 1 on page 37 shows the recording process and one type of thermoplastic film. The film has a base that is similar to the standard moving picture film base. On top of this is a transparent conducting coating, and on top of the transparent coating there is a thin coating of thermoplastic material which will melt if raised to a high temperature.

The surface of the thermoplastic is charged with an electron beam in a pattern that corresponds to the pattern of ripples that is to form the image. As the film moves on, a current is induced in the transparent conducting coating, which heats the film so that the thermoplastic coating melts. The charges are attracted to the transparent conducting coating and depress the surface of the thermoplastic. After the surface has been deformed by the charges, the film is then allowed to cool; this freezes the ripple pattern in place.

To erase the information, you simply heat the thermoplastic again to a higher temperature, so that the charges leak away and surface tension smooths the surface back out to its original state. The film is then reusable.

Fig. 2 on page 37 is a diagram of a recording machine that records on thermoplastic film in this way. The film, of course, must be handled in a vacuum, since the electron gun has to work in a vacuum. This is not nearly as much of a problem these days as one might think. It only takes about one minute to pump the machine down from atmospheric pressure to a vacuum low enough for effective operation.

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A standard projector has a plane light source, a condensing lens, and a projection lens. The light source is imaged on the projection lens by means of a condensing lens, and the projection lens images the slide to be projected on the screen.

If we now modify this so that instead of using a plane light source we use line light sources, and image these on a set of bars in front of the projection lens, no light will get through to the screen. If, however, we have *ripples* on the surface of the film at any particular point, these will scatter light through the bar system. Thus, the bar system acts somewhat like a shutter that allows light to pass wherever there is a ripple on the film. Whenever light passes through the projection lens, it images the ripple on the screen as a white spot. You can, for example, take a clear slide that simply has ripples on the surface, put it in the projector, and have it appear as a black-and-white picture on the screen.

This system can be modified so that it can be used to produce color pictures. Each picture element has in it a set of ripples that form a little diffraction grating. The light that is diffracted by this grating forms a spectrum on each side of the central beam. The slots are made small enough so that only one color from the spectrum gets through to the projection lens. Since the projection lens can receive only one color of the spectrum, the spot that appears on the screen will appear in a single color. If you would like the spot to appear in another color, you change the spacing of the grating so that a different part of the spectrum gets through the slot. In order to produce a color that is formed by a superposition of two or more colors, you superimpose the gratings in this spot and you get the superposition of the colors.

The film we use at our present stage of development is the size of standard 16 millimeter film. Our larger-size recordings use half the width of the film —the images are actually 5 millimeters wide—and the film runs at 10 inches a second. We are also recording with full resolution at half this picture size, so that the width of the track on the film is a tenth of an inch wide, with the film running 5 inches a second. In the latter case, this is the width of a half-track of standard audio magnetic tape.

As noted, however, we run at only 5 inches a second rather than at the 7½ inches a second used in audio recording tape. This is true, despite the fact that video recording requires approximately 100 to 150 times the density of information that is ordinarily required by audio. We are thus doing more than 100 times the work that an audio tape recorder does.

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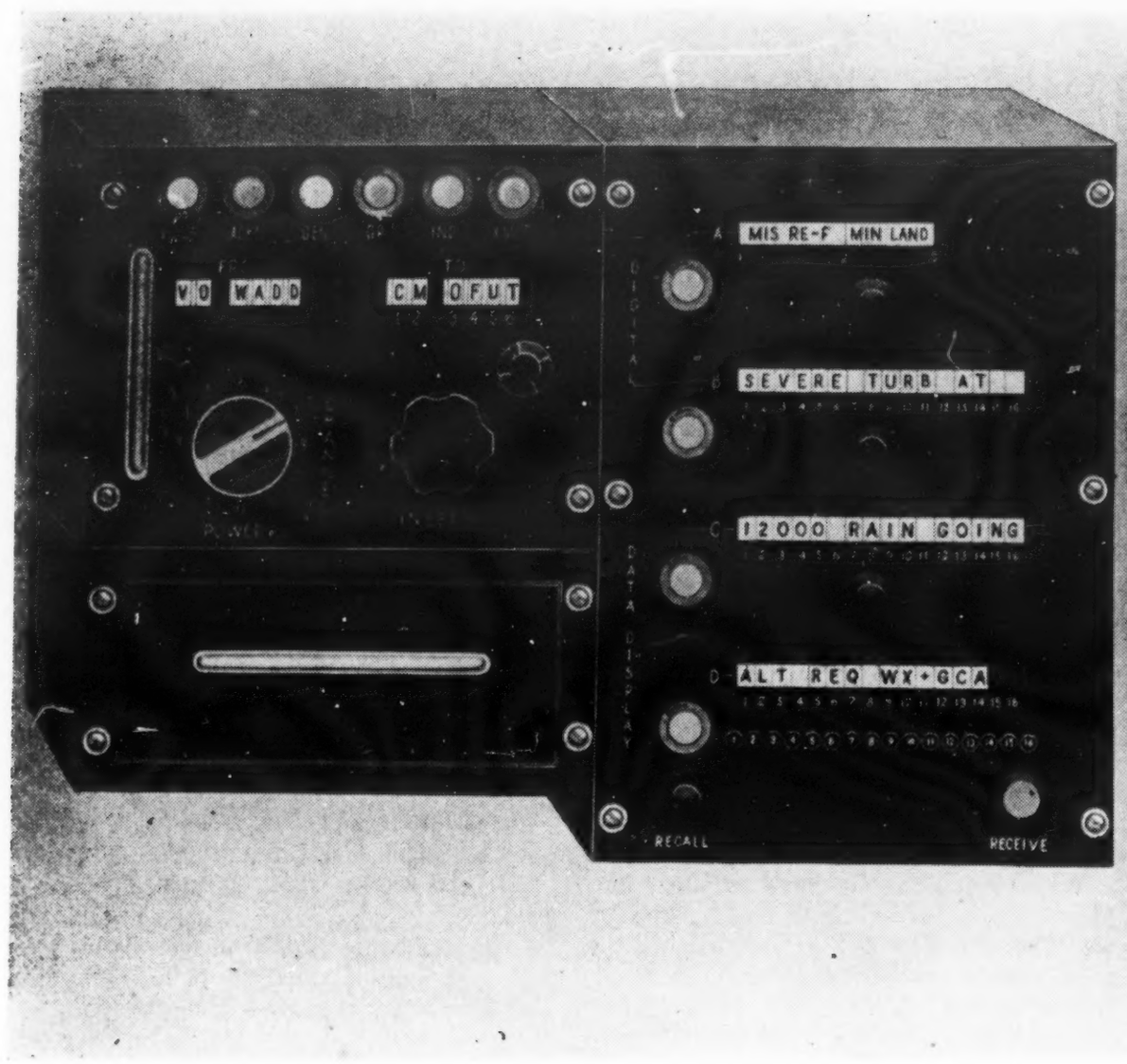

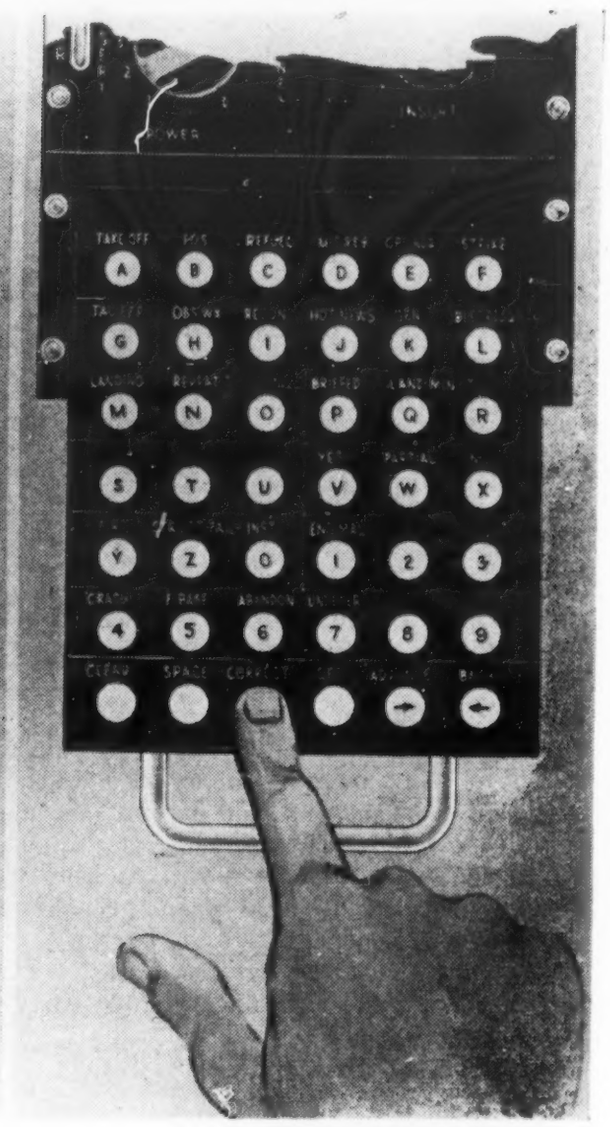

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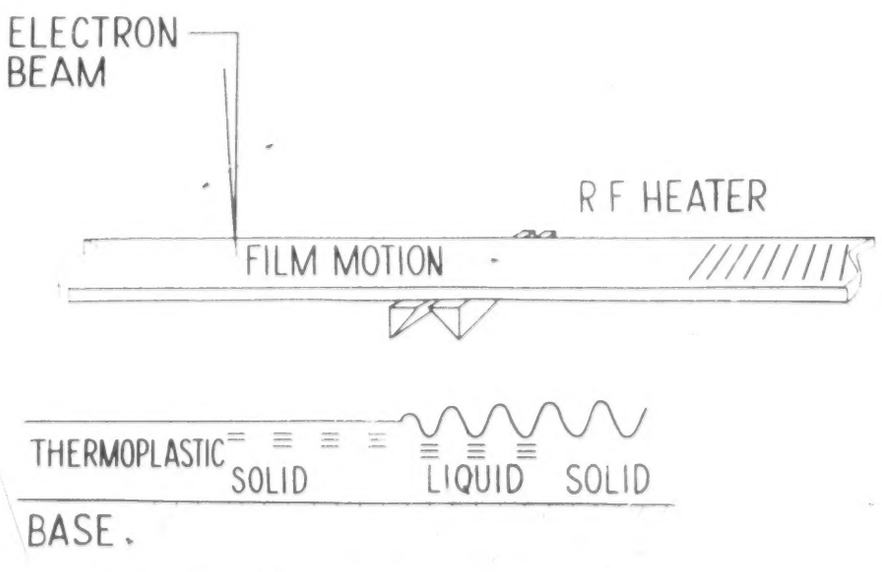

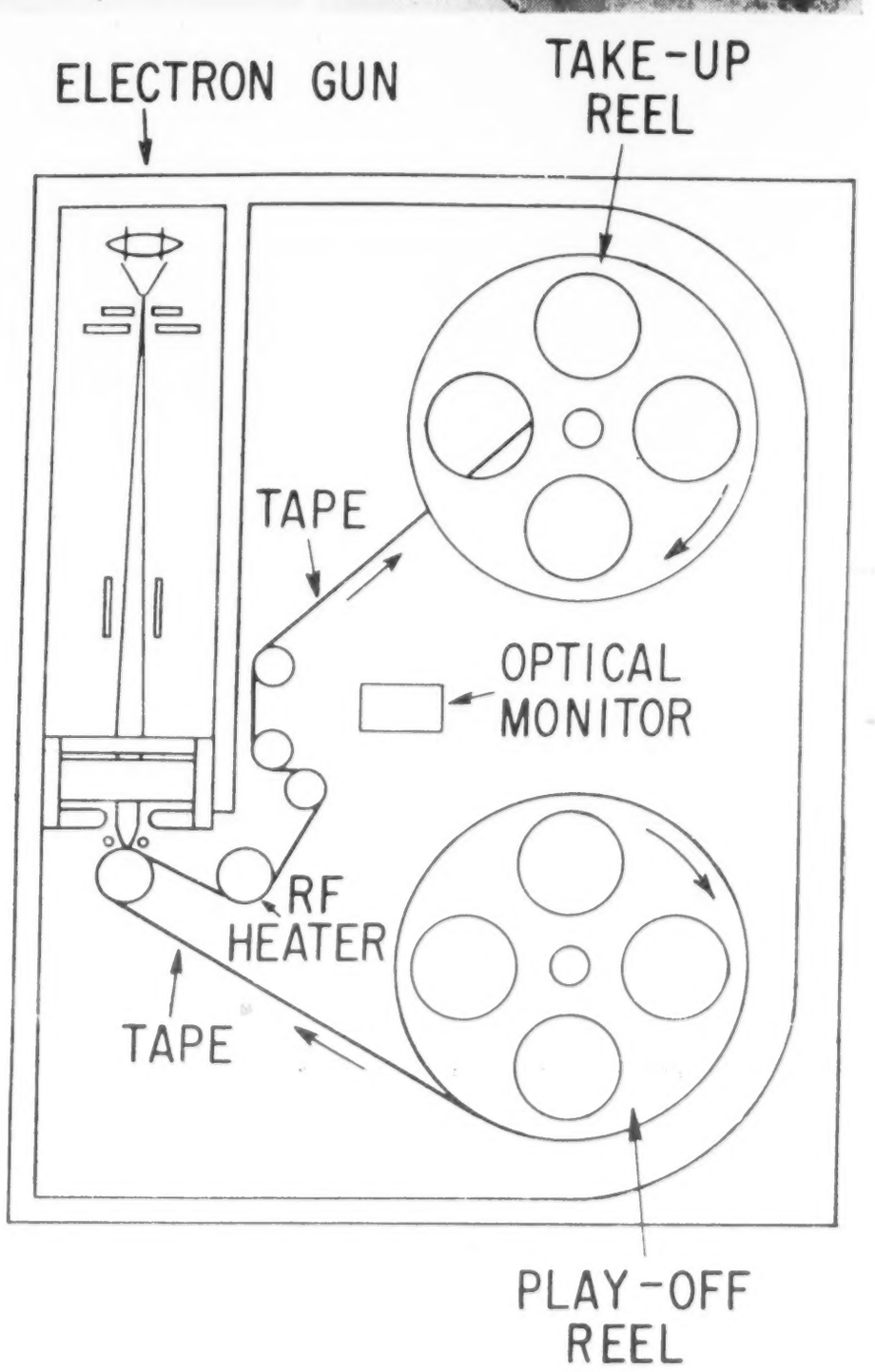

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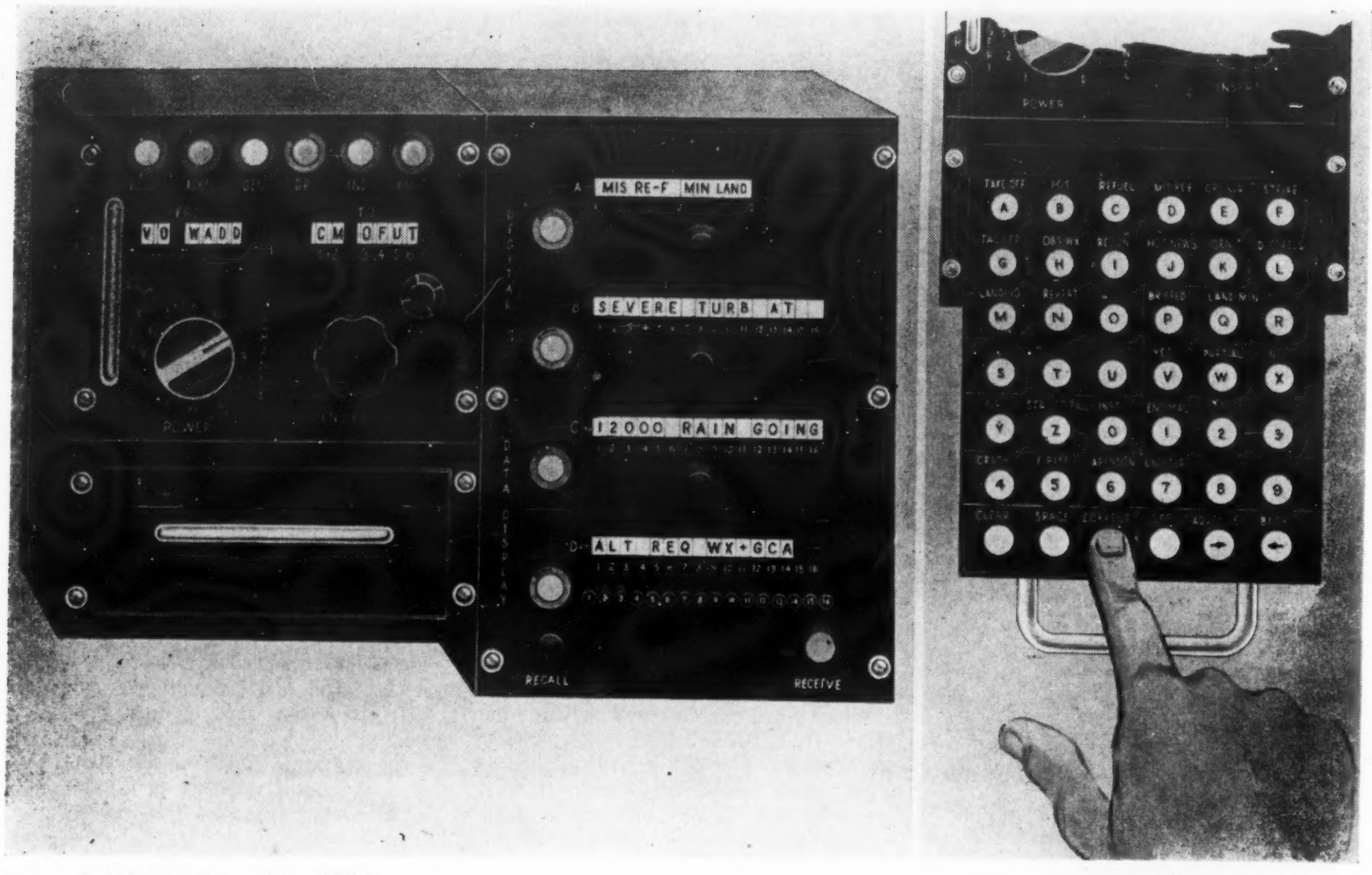

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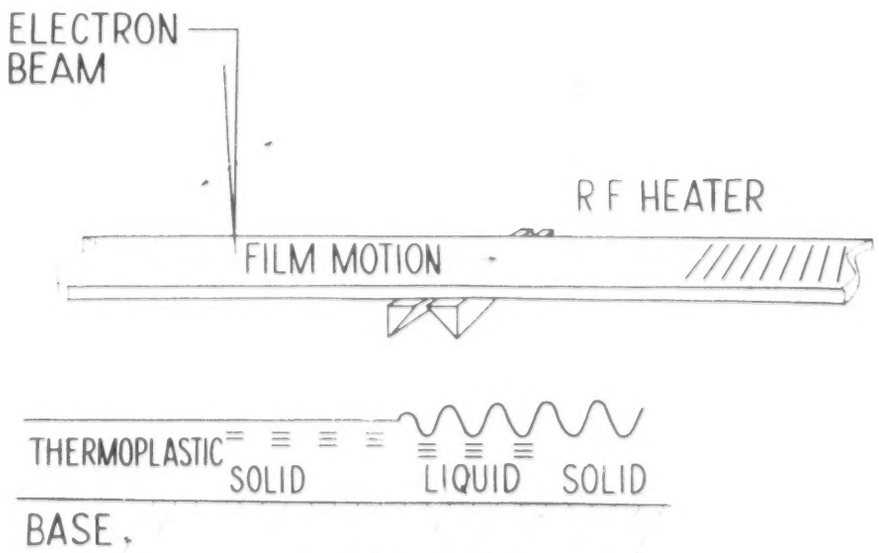

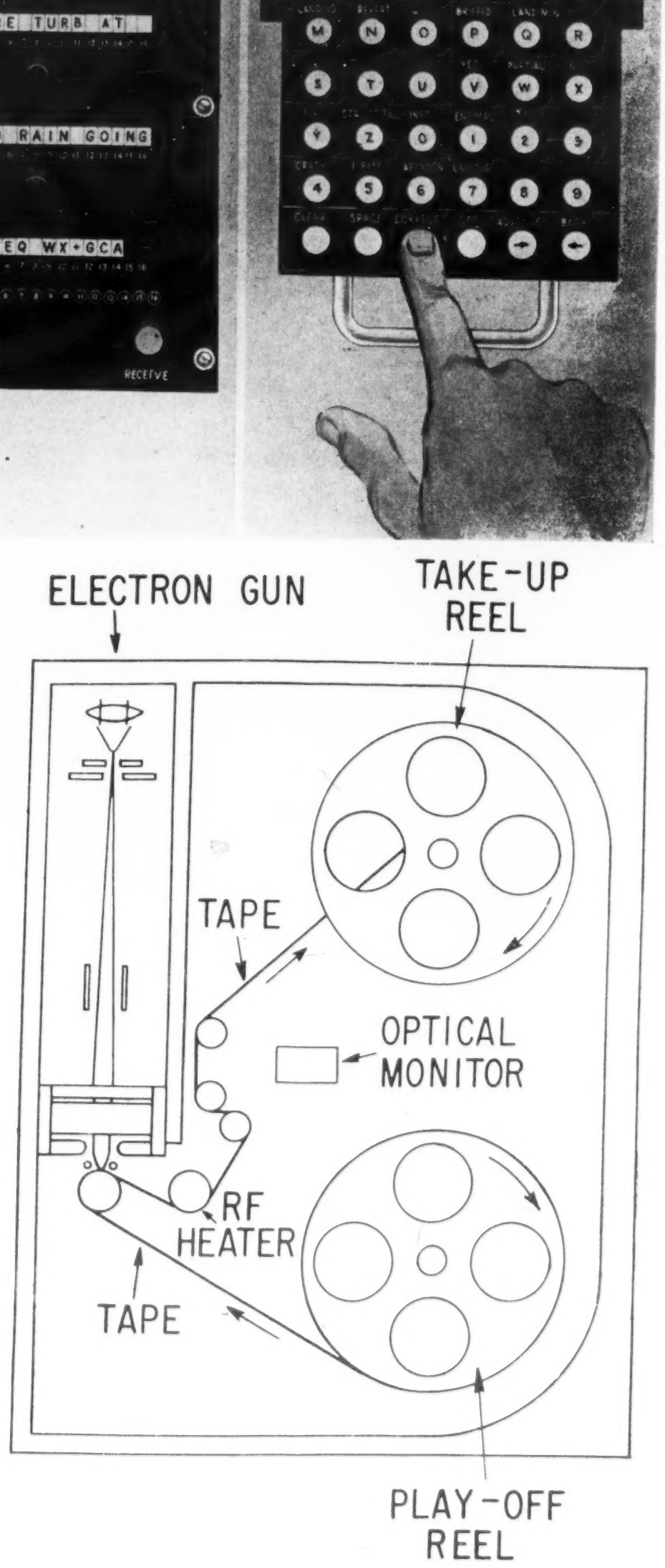

SYSTEMS PROFILE ANALYSIS

SPEAKER: RICHARD L. SHETLER, GENERAL MANAGER, DEFENSE SYSTEMS DEPARTMENT, GE

THERE HAS BEEN considerable misunderstanding on the part of the government and industry concerning the relationships involved in defense systems contracting. It would appear that there is a definite need to establish a frame of reference to serve as a guide during the planning and negotiation of the proposals for such contracts.

The basic premise to be presented during this discussion rests in the theory that a defense system—either a weapon or support system—has fifteen areas that could be delegated to a contractor by the government. In the past, during World War II and during the Korean War, industry has been required to work only on about half of these system functional contributions. This half was concerned chiefly with such requirements as service, installation and, of course, manufacture to name a few.

Present day technological advancements, however, have prompted most of the defense-serving industries to adjust their organizations in order to better deal with the changing requirements involved in the systems approach. Rapid innovation involved in the advancement of the state of the art now requires industry to become involved in the other requirements of a system's delegation profile. That is to say, industry must now consider such requirements as systems synthesis and systems programming along with the basic fabrication and design of the hardware.

This brings about the situation wherein the contract must be administered to provide maximum efficiency for systems programs during which research and development and production are required concurrently. The methods required to meet this demand have, over the past several years, been the subject of some very extensive studies by Congress.

These studies have been made to determine if the methods employed really provide the maximum defense per dollar. Secondarily, Congress has attempted to find out whether the methods delegate too much or too little responsibility to industry.

The interest of all those concerned centers around two basic points:

1. To insure that the Defense establishment maintains its responsibility for the defense posture of the United States.

2. To assure that the maximum efficiency—or in other words—the maximum defense per dollar is obtained for the defense budget.

Industry has been equally interested in the trend developing in systems procurement, particularly as this trend affects administrative methods and the efficiency which these methods may evolve. Of course, industry must study the requirements which the defense establishment imposes in order to be organizationally flexible. Only through such flexibility can industry stay efficient and competitive. In order to better organize to stay efficient and competitive, industry must thoroughly understand the job that must be done.

Some of this understanding can be derived by noting the differences between what is called a "compound" and a "complex" system.

When the nation requires a compound system, all industry has to do is pull items off the shelf and put them together to form the system. As an example, we could use a power generation system.

When you get concerned with a complex system, the job isn't quite as easy, and modern defense systems fall in this area. In a complex system you start from known items and work from there to the technology required to perform the system's function.

The systems designer in the complex system should not limit himself to known items—rather he should seek to advance the state of its art taking into consideration, of course, whether or not his research agrees with the laws of physics.

For example, the systems designer in the complex system may on frequent occasions come up with a system which requires 100 inventions. As long as these inventions do not violate any of the basic laws of nature he declares the system feasible.

Such recognition of the difference between compound and complex systems is vital to the preservation of our defense posture. We can no longer rely on compound systems to maintain our posture because we can no longer rely on known and proven items put together in a variety of fashions to give us the capability that we need. If we had relied on such a system in fact, rather than by definition, in the case of the intercontinental ballistic missile we would not have the missile today. If in fact, we had a recognition of the complex systems requirement in 1946 and had designed for a high yield, low weight warhead in spite of the fact it was not available, although not basically violating any laws of physics, we would have had an ICBM by 1951. It is in this category, particularly in the ICBM case, that the Soviets understood complex systems much better than we did. The Soviets adopted a complex system approach in the development of their massive boosters. They didn't anticipate low-weight-high-yield warheads, hence, they had to build for massive payloads. Whether the Soviets recognized or not the fact that they were pursuing a complex system definition and method of approach, no one knows; however, the results have had a devastating effect when you consider the performance they had with their high thrust boosters. These boosters enabled them to go ahead with a development which had no positive promise of use.

Today's scientists must stop and realize that we haven't time to simply reengineer and redesign devices already known in order to fulfill a requirement demanding an advance in the state-of-the-art. In specific terms it would be something like this—there is no need to produce lighter, longer-lived batteries when what we need is a minute device that will convert solar energy directly into usable quantities of electricity.

It is at this point in this discussion that the chief misunderstanding arises which has prompted the studies currently being made by the Congress. Technology has become so complex that equipments evolve as spin-offs from one design to the next within the requirements of one basic military mission. The military planners cannot hope to keep abreast of the continual evolutionary process of the defense laboratories unless they are willing to delegate functional responsibility to the defense-serving industries. If this delegation is too limited or restricted, we cannot hope to compete with the Soviet Union where no such delegation restrictions are imposed.

Components of the System Profile

Analyzing the situation in depth has led us to the idea stated previously—there are 15 basic contributions necessary to be melded together in order to successfully bring military system requirements to fruition.

These contributions can be classified starting from "A" and progressing to "O." Let's look at these for a moment. These functions must be defined briefly in order to understand the basis of this idea. Remember that not all of the points expressed are crystallized completely but are ideas which are believed to establish a frame of reference for the method which the military has used and must continue to use in the future to satisfy the requirements brought on by the complexity of rapidly advancing technology.

The fifteen areas that could be delegated to a contractor by the government are: Operation Analysis, Requirements Definition, Systems Management, Systems Synthesis, Systems Engineering, Systems Programming, Technique

Development, Research, Systems Design, Sub-Systems Design, Equipment Design, Equipment Manufacture, Systems Installation, Systems Test, and Systems Service.

You may assign different titles to the functional contributions—however, an attempt has been made to be as broad and conclusive as possible in order to cover the waterfront. The concept was established to convey the thought rather than to justify the specifics.

Operations Analysis

First under Operations Analysis should be included analysis of the political environment in which the military establishment must function. The political environment analysis will establish to a great degree the kind of defense posture needed and allowable over a given period. For example, if a complete stalemate of all-out war could be considered, (and it could only be considered if both we and potential aggressors had a complete capability in ICBM offense as well as a completely effective defense) then the requirements for strength would fall into the area of being completely capable in the area of limited war. This is to say that under a major all-out war stalemate, we could still expect brushfire or limited wars to exist and, further, that recognized sanctuaries such as we saw in the Korean situation would exist.

Second, Operations Analysis includes responsibility for physical environment analysis; this encompasses the usual things one considers whether the environment is under the sea, on land, in the air or in space. By this analysis, reference is made to the most likely environment in which any engagement might be fought and the limitations to that engagement which would be forced by that environment.

Finally, is added what might be called quantitative modeling. Here the contingencies and constraints established in the political environment and the physical environment analyses are quantitatively modeled to establish the depth and breadth of systems one must anticipate and, the method of deploying and employing these systems to obtain their optimum operational use.

As an example, let us examine the work content of Operations Analysis as related to the development and implementation of a missile defense system. This activity includes:

1) The definition of the defense role as one portion of our national strategy; the definition of the defense objectives may be the protection of our population, the protection of our retaliatory forces, or the prevention of global war as a result of an accidental firing of one missile.

2) The analysis of political implications of defense methods, such as enemy reaction to the use of anti-missile carrying satellites flying over his territory.

3) Effectiveness studies to compare the cost of meeting the objectives by means of missile defense as compared to other means. Examples would be comparison of cost of protecting population by missile defense as against a shelter program, or a comparison of protecting retaliatory forces by means of intercepting attacking missiles as against making the retaliatory forces mobile.

I must emphatically underline here that operations analysis of the type mentioned, that is to say, geopolitical, environmental and quantification comes in two phases in industry. First, it comes within our long range planning studies which we use for leads or internal configuring or risk-taking to put ourselves into a posture which will be useful to the government.

We don't dictate or explain to the responsible customer at any point in time what he should do about his basic plans. It is a naïvete to believe this for one moment. These plans are the internal problem of the planner or consultant. Personnel working in this capacity must understand that when any of their recommendations are accepted and used, they have not taken over the responsibility of the customer.

The second place where operations analysis appears is within the work established by agreement and contract. After the customer has made his basic plans within the sphere of his own limitations, this second phase must be called "Applied Operations Analysis," and it involves the use of special skills for the development of those things which have been deemed both technically feasible and militarily useful. In any case, industry cannot take unwarranted responsibility. Industry's role is not to help or to instruct the government in making its decisions.

Requirements Definition

A Requirements Definition narrows down the broad picture just previewed under Operations Analysis. Here the mission definition shall be basically established—mission definition might best be illustrated by such examples as: missile defense, missile offense, underseas warfare, intelligence and the like.

In addition, system definition must be included under Requirements Definition. Here, we are concerned with the broadest possible meaning of system definition. For instance, if we were to use the example mentioned earlier that the mission defined was missile defense, then you would have to break this mission down into various systems required to do the job.

Returning to our previous example of missile defense, we would include in this category the work of quantitatively defining the threat against which the system must operate, the work of breaking the system down into its subsystems and establishing quantitative requirements for each subsystem. We would, for example, determine in this work category whether early warning is needed and how much early warning time is required; when during the flight path of the attacking missile, we want the intercept to take place—close to launch, during its ballistic flight, or during atmospheric re-entry; what destruction mechanism should be used; what decision-making equipment is needed; and, how much time is available to make these required decisions.

It is necessary for the total decision system of our country to engage industrial competency when it comes time to consider the implementation of various military needs and developments. This, of course, does not mean that industry determines requirements. Nor does it mean even that industry plays a major role beyond certain specific technical spheres in determining that we realize that the deliberations and requirements include many different factors of which some have to do with the readiness of technology as it is industrially organized to participate in implementation. These so called requirement studies engaged in by industry essentially have to do with this peculiar thing and the treatments of military utility, and geopolitical considerations, and so on.

Up to now, industry has not understood this phase of planning any too well. We must make sure that we have done everything to assure that our most sensitive understandings of broad military situations have been aligned with the need-to-know counterparts within the customer organization. These roles must be given proportionate weight in the decision chains having to do with our internal adjustments and alignments for skills and practices. Only when each responsible agency sees itself as a part of the over-all defense picture and understands its need to play a particular role as is fitting within that picture, can defense planning be improved. It is when individual components of the picture choose to image themselves against the total problem and pick out ineffective performance of the picture as a total and as an excuse for deliberate aberration from its proper role that those component parts deserve censure.

Systems Management

Under systems management many things are incorporated. The first of these is cost effectiveness analyses of the systems defined under Requirement "B" (paragraph 2 under Requirements Definition). For example, one could conceive of a system for missile defense which would be 100% effective but would bankrupt the nation. Under Systems Management are composed other fiscal responsibilities such as establishing funding criteria, cost analysis criteria, (this being more specific than the cost effectiveness evaluation), subcontracting requirements (that is to say that all segments of the industry with the capability to contribute do contribute), data reporting requirements, and so on. Also added here is responsibility for auditing of the fiscal results as well as technical results. At this point the system engineer becomes concerned with the planned utilization of current and new government furnished facilities. Finally, he is concerned with surveillance of the over-all contract which

placed the defense establishment in a position to act freely, based on their evaluation of the progress seen throughout the life of the contract.

Systems Synthesis

Under Systems Synthesis I include the actual conception of the system in terms of the role played by detection equipment, decision making equipment, intercept vehicles, the number of units required, and the gross performance parameters of each subsystem. I do not include under the responsibility the technology required in construction (construction of the target location equipment, for example).

Systems Engineering

This includes the technology to be used. In our missile defense example, this includes the selection of the type of technology for each element of the mission. For example, it is here that we decide whether to use radar or optical means for detecting the attacking missile, and whether we use missiles launched from the ground or from aircraft to intercept the attacker.

Systems Programming

Systems Programming establishes the general operating methods employed to engineer and design the system synthesized earlier. The responsibility to coordinate and define the systems concepts which have resulted from the synthesis and the engineering which preceded is factored in at this requirement. Also to be established at this level, in a manner which would permit and insure complete concurrency, would be the development of the milestones for technique development, equipment development, integration of major sub elements, reliability equipment and system testing, field personnel criteria and logistics support.

Let's take a look at system design. In this category I include the generation of system function specifications the system elements must satisfy. With respect to missile defense this includes the range, power, wavelength and coverage area of the target location radars, the speed, range, payload weight of the intercepting missile, and the equations to be solved by the computing equipment. The result of this portion of the effort is a set of specifications for sub-system design.

System design would block diagram the device and would establish the technique development necessary to bring this block diagram to fruition. For example, radio frequency would be established, along with other electronic equipment requirements, and would be described from a specification and requirement standpoint to fulfill a block diagram. These designs would be passed on as specifications to subsystems design.

In progressing through the systems to the subsystems design—the system designer in an electronic system, which we are using as an example, passes on the specific performance requirements, and test data, and so forth. The subsystem designer establishes the specifics of the design. Passing then quickly to the next stage, technique developments necessary to fulfill the system requirement would be gotten underway. The technique development would pass breakthrough requirements on to the research team, if it found itself against a road block requiring further research. This, as you can see, is a successive approximation technique. When these levels of activity are complete, the equipment designer goes to work. He actually puts together the circuitry necessary, conducts laboratory tests, designs the circuits for production and supervises equipment manufacture. The equipment produced then goes to the systems installers, and there is system-tested and passed to system service, then into the operational stage. You can see that it is necessary to have successive feed-back all the way along the line from one requirement to another. As each step is taken, each preceding step must not fail to reflect the effect of the operation of the subsequent step.

We've spent a considerable amount of time describing for you the influences which complex systems requirements have brought to the defense contracting business. We feel that these influences have prompted most of the defense serving industry to adjust their organizations to the changing requirements which involve a greater delegation of responsibilities from function 1 through 15.

For example, the General Electric Company has established a Defense Systems Department where we have a capability in varying degrees in all functions 1 thru 15. A systems contract manager could look back at the profile described and the company bidding on the work and check that company's organization concept against the requirements of the profile. In order to insure an efficient and successful contract he would need to find a contractor whose capability exactly meshed with or exceeded the requirements and demands for contribution that he proposed to delegate. This situation is one to which industry is attempting to become most responsive and is the one towards which industry is directing a great deal of its attention.

Nothing said so far would indicate that it would not be possible for the military to have relinquished its position of management responsibility for the fineness of the systems being built to fulfill the defense requirements of the country.

In looking the situation over (particularly the experience which you can consider as having been gained since World War II) we have come up with the idea that defense contracting runs through a typical evolution. This evolution has its beginning, in each case, in a new technological breakthrough, or in a new requirement to meet a technological breakthrough made by a potentially aggressor country. In dealing with three areas—government delegation, the role of the prime contractor, and the role of the subcontractors—we find the scope of responsibility assumed by each of these contributors will vary.

In the simplest method of contracting, the defense establishment lets a single prime contract for a well defined item. This method is used usually when the item to be procured can be more or less exactly specified, and where this item does not involve the complex integration of many dissimilar items which are called sub-systems in today's terminology. We have called this kind of prime contract arrangement (where the defense establishment does not direct the placement of subcontracts on specified segments of the industry) an equipment contract.

Basically, in this type of arrangement the prime contractor has complete control over the technological development made by the subcontractors and has complete responsibility for supplying an integrated item which satisfactorily meets the defense establishment's specification.

In the second step of complexity, the technology has developed to such a point that the military agency finds it does not have the required technical organizational breadth to define all of the many required facets which insure the satisfactory technical niceties of the desired item.

In this instance the defense establishment chooses to let a number of contracts. The most important of these is the technical direction contract. This contract includes responsibility for insuring that the other contractors meet the technological interfaces of the item's various segments, which in this case would be a system. The defense establishment would then let prime contracts to associate contractors who would be responsible for basic functional elements of the system, and responsible for integrating the interfaces with their associates under the direction of the technical direction contractor. We quickly detect that this type of contracting is basically the type used by the Ballistic Missile Division/Ballistic Missile Center complex in the Atlas, and other ballistic missile programs. This method of contracting, in spite of its excellent performance over the past five years, has been under considerable fire by various segments of the government.

In the next step in contractual complexity which one might expect to encounter, the military or defense establishment finds that it does not have either the technical depth nor the total business depth to control the management of the system which it needs to fill a fundamental requirement. The lack of this depth should in no way be construed as a criticism of the defense establishment. Rather, it is a tribute to the fact that the technology today has resulted in such a diverse set of

requirements that the military finds itself in a position where, in order to pursue all the paths, it must spread its talents as thinly as possible in the actual hardware and technology management area and lend the major share of its talents to the analysis of the operational requirement and the analysis of the operational method.

In the systems management concept, the military lets a contract to a single prime contractor to develop and construct the necessary subsystems to demonstrate and perhaps to fabricate a final system which can be turned over in operational condition to the using agency. This type of contract is relatively rare and to my knowledge has been used only in a few instances. One of these that comes to mind is the Nike System, and the second is the B-58 system.

These types of systems are somewhat unique and while it is believed this type of contracting is necessary in relatively rare cases, it can be argued that this type of contracting will become a basic way of life in the defense business.

At the completion of this cycle the military would assist the systems management contractor in selecting the successful subsystems bidders who would be called the prime contractors. The military would then let the prime associate contracts directly from their own business management establishment. They would, however, at that point have delegated the authority for the systems management to the original segment of industry involved in the systems management contract. The systems management contractor would have responsibility in varying degrees in addition to his systems management responsibility for systems synthesis which would have been basically complete at the time the prime associate contractor was selected,—a continuing responsibility and authority over systems engineering, systems programming, systems design, systems service, systems test, systems installation and a surveillance responsibility over subsystems design.

At this point I would like to digress to say that variations of any of these four cases could be illustrated. However, it seemed important to me to simplify into the basic generic types of defense contracts one might conceive rather than to consider the perturbations one could expect under specific conditions. This, to my way of thinking, is the method we will see most frequently over the next four or five years. In this instance the military would let a prime systems management contract to a specific segment of the industry and would direct that prime contractor to conduct the systems synthesis and to prepare the subsystems specifications as well as advertise these subsystems specifications to segments of the industry who would compete in the usual fashion to develop, design and build those subsystems.

One fact remains irrevocable, however, and that is this: our military planners are subject to a great degree to the developments made by industrial research which affect weapons and their use. It is no longer sufficient for companies merely to stand ready to satisfy military requirements. Industry must now work jointly with the Department of Defense in planning that spans decades. This does not mean that industry has the right to expect that it can sit in the council of the policy-makers. Industry must recognize that the people do not want their government to relinquish its policy making role. The ultimate decisions must still be the responsibilities of the agencies charged with the ponderous task of keeping the United States the strongest military power on earth. Industry's role, therefore, is *not* policy making.

If industry recognizes this, then the military must fully realize that it cannot define new requirements and expect industry to produce the hardware required to satisfy those requirements overnight. The military must also realize that it must keep industry informed —as far as is practical in the light of security and need-to-know—of the influence that policy may have on weapons technology.

I sincerely believe that the Department of Defense knows that industry must be planning, researching, and developing new technologies actually in advance of the military requirements for them. Our military know that Soviet military-industry progress achieved through a narrow compulsion toward military goals must be more than matched by even greater U. S. progress achieved through the full utilization of the superior capabilities of our private industry. We must make the most of our basic advantage of having a free enterprise system, even though that system compels the same anvil that forms the plowshares to form the swords. This must be done jointly since the Soviet Union now believes it can compete with us economically as well as militarily.

Hence, the military and economic destinies of the American people are solidly linked together, and they cannot go their separate ways. On the side of the military it must be recognized that one of the chief contributions industry can make in this relationship is one of superimposing its management skills over the profiles of defense planning and implementation. In fact, in my opinion, the number of defense innovations we can expect is directly proportional to the management talent we can bring to bear on the research and development required to bring these much-needed innovations to a practical fruition.

The feather merchants and the soldiers must cast their lots in together and come up with a solution for a workable military-industrial relationship. Unless this solution is forthcoming the very freedom encompassed in our free enterprise system may be the chief cause of ineffectual competition with the Soviets.

120 EQUALS 1 PLUS 0

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exhibit spaces available for the 15th AFCEA Convention. Arrangements have been made for the usual 110 exhibits at the Sheraton-Park Hotel plus 120 additional ones at the Shoreham Hotel which more than doubles AFCEA exhibit capacity. Limousine shuttle service will operate continuously between the two hotels, only two minutes apart. Plan to attend.

15TH AFCEA CONVENTION • JUNE 6, 7 AND 8, 1961

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Defense Electronics and the Engineer

(*Continued from page 7*)

profitably employed. But this must not be accomplished by merely reassigning every engineer, as he becomes available, to military programs that are already adequately staffed, with a complete disregard for engineering economy, professional pride and personal motivation. We have already hurt the electronics engineering profession in America by accepting more or less as a necessary evil a level of low productivity in military engineering. We must not let this professional dry rot spread uncontrolled—as it could well do in the next few years when many thousands of technical people are released from engineering work in the areas of continental air defense and manned-bomber electronics. I believe it is time we took a searching and comprehensive look at the national posture with respect to electronics engineering.

It is quite possible that the country would be better off if more of our electronics engineering resources were applied to commercial areas—perhaps to reduce manufacturing costs so that the products of our industry would have a better competitive position in the world market.

Increased Engineer Productivity

I am confident that things could be done in Defense to increase the engineers' productivity and to control the number of engineers applied to specific Defense programs. A thorough study of the entire problem is needed before it can be completely understood and its solution determined. However, I would like to suggest some steps I believe would be helpful.

(1) The use of the cost-plus-fixed-fee method of contracting should be studied carefully to see whether it could not be more restricted. A large part of the problem I have discussed would disappear if competition and cost incentive could be introduced into government contracts for engineering work.

(2) I believe there is an urgent need for the military departments to increase the capabilities of their project-direction people and develop their understanding of engineering management. After all, they are in the best position in Defense to determine the productivity of engineering on these projects and to exercise some control over engineering padding. This factor is closely related to the weapon-system concept, which has tended to reduce military control of engineering.

(3) Most important, the Department of Defense must direct more technical resources into applied research and exploratory development work rather than hardware development. A major reason for cancelling projects is that we undertake so many hardware-development projects that we cannot afford to produce all of them within our limited Defense budget. Also, because so much component and technique development is done on system contracts, the time scale is extended so far that the systems often become obsolete—or the need for them disappears—before they are ready for production. I am thoroughly convinced that many more creative electronics engineers could profitably be transferred from hardware development to component and technique development, particularly in areas supporting defense against ballistic missiles and antisubmarine warfare.

As I have said, I have presented this problem without a thorough understanding of its magnitude or its implications. I am so concerned about the future, however, that I feel justified in stimulating some immediate thought and study in this direction by management people throughout industry and the military departments—particularly by members of the AFCEA!

Frequency Allocations

THE ITU CONFERENCE—GENEVA 1959

By ALBERT L. McINTOSH
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OCSigO

AN IMPORTANT world conference was held in Geneva, Switzerland from 17 August to 21 December 1959. The actions it took are of the greatest significance to radio users everywhere.

The eighty-eight governments represented at the Conference are members of the International Telecommunication Union (ITU). This Union periodically reviews and revises the international radio treaty in force. The existing treaty was negotiated at Atlantic City in 1947. Subject to U. S. Senate ratification, it will now be replaced by the 1959 Geneva treaty on 1 May 1961.

Among other subjects, this treaty sets forth the basic allocations of spectrum space for different uses of radio. Certain frequency bands are designated for broadcasting, others for mobile communications, still others for radars, amateurs, aircraft, ships, and so forth.

The competition for radio spectrum space among the different groups of radio users is always keen. The 1959 Conference witnessed a resumption in the usual rivalry between the older established users of radio. It also was faced with demands from new users not previously recognized in the radio treaty. Chief among these new uses are radio astronomy and space vehicles. The 1947 treaty allocated the radio spectrum up to 10,500 Mc/s. The 1959 treaty adopted allocations up to 40,000 Mc/s.

Let's take a look at the impact of this new treaty on some of our better known uses of radio.

No-Reduction Victory for "Hams"

The radio Amateur service is one of the oldest recognized uses of radio. In the United States, for example, we have in excess of 100,000 licensed Amateur operators. These "hams" engage in electronic experimentation, the design of new types of receivers and transmitters, and collectively they make major contributions to our progress in communications-electronics. They also establish "on the air" friendships with other "hams" throughout the world and make an important contribution to better understanding between the peoples of different countries. The "hams" are always ready in event of emergency to establish the radio communications necessary to preserve the safety of life and property and to serve their communities and their country in every appropriate way.

The frequency bands which the "hams" use for all these purposes are specified in the international radio treaty. These bands represent only a very modest portion of the radio spectrum. Many of the governments represented at the 1959 Radio Conference advocated a reduction in the size of these Amateur frequency bands. The United States Delegation to the Geneva Conference took a strong position in favor of maintaining the traditional Amateur frequency bands without reduction. After a considerable amount of debate and negotiation, the United States position prevailed and Amateur operators throughout the world can breathe a sigh of relief for a few more years, at least until a future Conference again takes up the question of the allocation of radio frequencies.

Way Paved for Modernization in Maritime Uses

The Merchant Marines, as well as our fishing fleets and yachtsmen, use radio extensively for ship-shore communications. What did the 1959 Radio Conference do for the people interested in maritime uses of radio? First, all of the frequency bands specified in the 1947 treaty for maritime uses of radio were retained. In addition, the Conference evolved a reorganization of the long-distance frequency bands used by our ocean-going ships so that there can be a gradual introduction of the more modern methods of communications, such as radioprinters, facsimile, and data transmission systems. At the same time, adequate provision still is made in the new treaty for the continuation of the familiar manually operated Morse code system of ship-shore telegraphy. The ocean-going ships equipped with long distance or High Frequency radio-telephones can now anticipate the world-wide introduction of single sideband technique under the new treaty. In the Very High Frequency (VHF) short distance band a considerable number of standard world-wide radio-telephone channels are set forth in the new treaty so that ships of all nations going from one country to another may use their VHF radio telephones without adjustments in frequencies, crystals or tuning ranges. In other words, a vessel which has a standard VHF radio-telephone for use in the New York port area may now use the same frequency channels for the same functions in any port in the world. This type of frequency standardization is and always has been one of the essential objectives of the ITU.

Solutions for Expanding Aviation Requirements

In the aviation field the 1959 Radio Conference was faced with serious frequency allocation problems arising out of the advent of jet aircraft and the acceptance by the aviation industry of various types of airborne electronic aids to navigation. The Conference met this challenge and undertook a technical appraisal of the actions which would be necessary to satisfy these expanding aviation frequency requirements. At increased altitudes, the "line-of-sight" distance from an aircraft to the horizon is increased, hence the "interference area" increases. In turn, this increases the total number of frequencies required. The VHF band for air-ground communications in the aviation service was extended above 132 Mc/s by 3 Mc/s in some areas of the world and by 4 Mc/s in other areas. This will permit the introduction of many new air traffic control stations as well as the increasing of the geographical separations between many

of the existing ground stations.

In the frequency bands available for electronic aids to air-navigation, the 1959 Conference set a precedent by specifying for most of these bands that they are reserved on a world-wide basis for use and development of airborne electronic aids to air-navigation and any directly associated ground-based facilities. Thus manufacturers and developers of these types of equipments, as well as the aviation industry and the governments responsible for assigning frequencies, can all work towards the development of these important adjuncts to air safety in standardized frequency bands which have the stability of a world radio treaty to support them.

Overseas Point-to-Point Users vs. Short Wave Broadcasters

The overseas communications companies which provide direct public telephone, telegraph and other radio communication services directly between the United States and most of the countries of the world had a tremendous stake in the negotiations at the 1959 Radio Conference. The services provided to the public by these communications common carriers are often taken for granted, but they would be impossible or would have to be curtailed if enough frequency space were not allocated for them. The trepidations of these interests as the Conference opened were not without foundation. Earlier Conferences had reduced the amount of frequency space for these overseas point-to-point uses of radio in order to expand the frequency space for short-wave broadcasting. When the Geneva Conference began there were definite signs that certain countries wished again to reduce the number of point-to-point frequencies to provide further expansion of the frequency bands for short-wave broadcasting. Of course, the United States is deeply interested in short-wave broadcasting and, in fact, operates its Voice of America transmitters in the short-wave broadcast bands designated in the ITU Treaty. For this reason the United States Delegation to the 1959 Conference could not in any way deprecate the importance of allocating frequencies for short-wave broadcasting. At the same time the Delegation was compelled to find ways to maintain the point-to-point frequency bands without any reduction. As in all international negotiations of this type, much of the work was done behind the scenes and in informal discussions between Delegations. Following consultations between the United States Delegation and Delegations of other countries throughout the world, a test vote came in the Conference. The final decision was to maintain the long-distance point-to-point frequency bands without any reduction. This was probably the most important decision of the Conference.

Frequency Management for Short-Wave Broadcasting

This decision left dangling the question of how the various countries could get better use of the short-wave broadcasting bands. These bands are extremely congested with transmitters operated by almost every country in the world. The interference which the short-wave listener receives is quite intolerable. It would not be in keeping with the traditions of the ITU if this situation were ignored. Therefore, the question arose as to how this interference in the short-wave broadcast bands could be reduced if the frequency bands available for short-wave broadcasting were not expanded. A scheme of improved frequency management for these bands had been carefully drafted by a U. S. Government-industry preparatory committee in Washington prior to the Conference. This plan was carefully explained to the Conference by the United States Delegation. After careful study it was adopted with some relatively minor amendments. The essence of this plan is to require the ITU headquarters in Geneva to act as a clearing house for the program schedules of all short-wave broadcasting stations. Each government will furnish Geneva with advance information about their program schedules so that mutual interference between short-wave broadcast stations can be spotted in advance and appropriate adjustments in frequencies and schedules can be made by the countries concerned before the interference occurs. This is far from a panacea. But it is a precedent and a typically realistic ITU approach to a general interference problem confronting the various countries.

The new treaty does not change the bands for standard AM, FM or TV broadcasting.

Radio Astronomy and the Space Age

A number of frequency bands were designated in the 1959 Radio Treaty for radio astronomy. We all know that our progress in the Space Age is directly dependent on our knowledge of the Universe. Each item of information which adds to our store of knowledge contributes directly or indirectly to our eventual ability to learn the secrets of the Universe. Finding these frequency bands for radio astronomy throughout the world was a difficult task because most of the bands desired by the astronommers were already allocated to older and well established uses of radio. Nevertheless, the Conference faced up to this challenge and adopted allocations which the representatives of the astronomers said were quite satisfactory.

Of course, the advent of space vehicles took place after the 1947 Conference. The necessity of recognizing that frequencies would have to be provided for communications with space vehicles was soberly understood by the Delegates to the 1959 Conference. It is noteworthy that even though only two countries are launching space vehicles at the present time. Delegates of all countries were eager to understand this problem and to cooperate in its solution. As a result, the 1959 Radio Treaty specifies certain frequency bands for space research communications. The Conference went even further and recognized that a special Conference may be necessary as early as 1963 to provide frequency bands for space communications satellites, that is, space vehicles which act as relay stations for transoceanic communications, relaying of broadcasting programs, and so forth.

The United States is using radio in many ways to further its national objectives and to support its general economy. Considering the tremendous stake that it has in the use of radio throughout the spectrum and the possible adverse effects which could have resulted from decisions of this Conference, we can sum up by saying that our opportunities to enjoy the many benefits of radio will be maintained under the new radio treaty. From every point of view, the treaty produced by the Conference will benefit nations generally.

The Delegation which represented the United States at the 1959 Conference was comprised of both Government and industry representatives, all under the direction of the Department of State. Of the Government members, those from the military services played key roles. The principal spokesman for the United States on the Frequency Allocation Committee as well as the U. S. spokesmen on several of the Working Groups reporting to the Frequency Allocations Committee were officers or civilians from the Departments of the Army, Navy and Air Force.

COMMUNICATIONS and CIVIL DEFENSE

Putting communication facilities into service for the Nike command post at Wilmington are L to R: Lt. Col. C. R. Arvin, Chief of Cincinnati Defense Area Command; R. Gibson, Assistant to Ohio Governor Michael V. DiSalle; Col. M. Bywater, Div. Cmdr. of Clinton County AFB; Wm. Oertel, Exec. Dir., Ohio Newspaper Assoc.; Bates Harcum, Mayor of Wilmington and Clare E. Williams, President, General Telephone Co. of Ohio.

THE COMMUNICATIONS SYSTEMS of four new Nike missile batteries located near Wilmington, Felicity and Oxford, Ohio and Dillsboro, Indiana have been activated. All four bases, which form part of the Cincinnati Air Defense Command, are equipped to launch the Nike Ajax and the Nike Hercules missiles. Purpose of the sites is to guard Ohio's southwestern industrial complex.

Representatives of the Second U.S. Army, the Army Air Defense Command, the Strategic Air Command, Office of Civil Defense, the executive and legislative branches of state and local governments attended ceremonies marking the activation of the communications systems. Guest of honor and chief speaker was Clare E. Williams of Marion, president of General Telephone Company of Ohio, the company responsible for installing the communications systems for the three Ohio sites. The Southern Indiana Telephone Company installed the site at Dillsboro.

In his remarks, Mr. Williams stated, "The installation of the Nike system in southwestern Ohio was completed in record time and it was only through the cooperation and support of the Fifth Missile Battalion, 56th Artillery and other branches of the Army involved that we were able to complete our phase of the new installation also in record time. I can only offer the highest praise for the excellent working relationship which we have had with the Cincinnati Air Defense Command Headquarters in Wilmington.

"As most of you may know General Telephone Company of Ohio is part of the General Telephone & Electronics Corp., a rapidly expanding organization with domestic operations, which now includes more than 50 manufacturing plants and 24 laboratories in addition to 30 domestic telephone operating subsidiaries, serving 5,500 communities in 31 states, including Alaska. Just recently Donald C. Power, GT&E Chairman, announced that Sylvania Electric Systems, a division of Sylvania Electric Products, Inc., has been assigned over-all responsibility for coordinating the broad defense systems management of the various GT&E subsidiaries. This new organizational concept has been designed to meet both specialized military requirements and the expanding technology of electronics—a defense business which is expected to double in the next five years.

"We are genuinely proud to be a part of this United States Army Cincinnati Air Defense Command, . . . the Clinton County Air Force Base . . . and this great community of Wilmington which in our opinion has a tremendous potential for community and industrial development."

Mr. Williams emphasized that, "every American adult, civilian or military, should have a direct interest in and should support local and national defenses. This Nike system is a protector of the homefront and is an asset to the southwestern Ohio area."

Lieutenant Colonel Charles R. Arvin, commander of the Cincinnati Air Defense Command, 5th Missile Battalion, 56th Artillery Division, paid tribute to General Telephone for its cooperation in establishing in record time the radio and telephone systems for the area.

"In this day and age the defense commander relies entirely on the electronic eye of radar and communications systems to flash instant warnings and orders. Gone are the days of couriers, dispatches, maps and reconnaissance; time is of such importance that information must be received, evaluated and disseminated at once.

"With our radar screen stretching from the Arctic Circle down to every defense post, we have our eyes. With the radio-telephone equipment installed and maintained by General Telephone Company of Ohio, we have the ability to receive and transmit intelligence and orders instantly throughout the North American Air Defense. Thus, we are capable of engaging in an air defense battle within minutes after a warning."

In briefing his guests on the operations of the base, Colonel Arvin told the group that no aggressor could get within 500 miles of this area without being seen on the radar screen—and subsequently "killed" by a Nike missile. Asked if a missile with an atomic warhead could be launched from the four sites around Cincinnati, Colonel Arvin said missiles stored at the bases are capable of carrying such a warhead. "However," he confided, "I cannot confirm nor deny if we have any on these bases."

The local base has a radar pickup area flanked by Washington, D. C. to the east, St. Louis to the west, Detroit and Cleveland to the north and Chattanooga, Tennessee to the south.

Around 600 officers and enlisted men operate the command post near Wilmington and the four Nike batteries that make up the defense system.

air force titan and amf

THE AIR FORCE has awarded a contract in the amount of $81,567,000 to American Machine & Foundry Company. According to Brigadier General Don Coupland, Commander of Air Materiel Command's Ballistic Missile Center, Los Angeles, California, the contract calls for construction of 36 new launcher systems for the Air Force TITAN Intercontinental Ballistic Missile.

Air Force officials said that the contract will be on a cost plus incentive fee basis. This new contract brings AMF's participation in the ballistic missile program of the Air Force to some 166 million dollars.

AMF will produce and install 36 systems, equipping four squadrons with nine operational launcher systems each. They will be located at Ellsworth Air Force Base, Rapid City, South Dakota; Mountain Home Air Force Base, Boise, Idaho; Larson Air Force Base, Moses Lake, Washington (near Spokane); and Beale Air Force Base, Marysville, California (near Sacramento).

Under the new TITAN contract, manufacture of the equipment will be done at AMF's TITAN Production Division at Greenwich, Connecticut and at the Buffalo, New York plant. Field engineering groups at the four locations will be established to install and test the TITAN launchers.

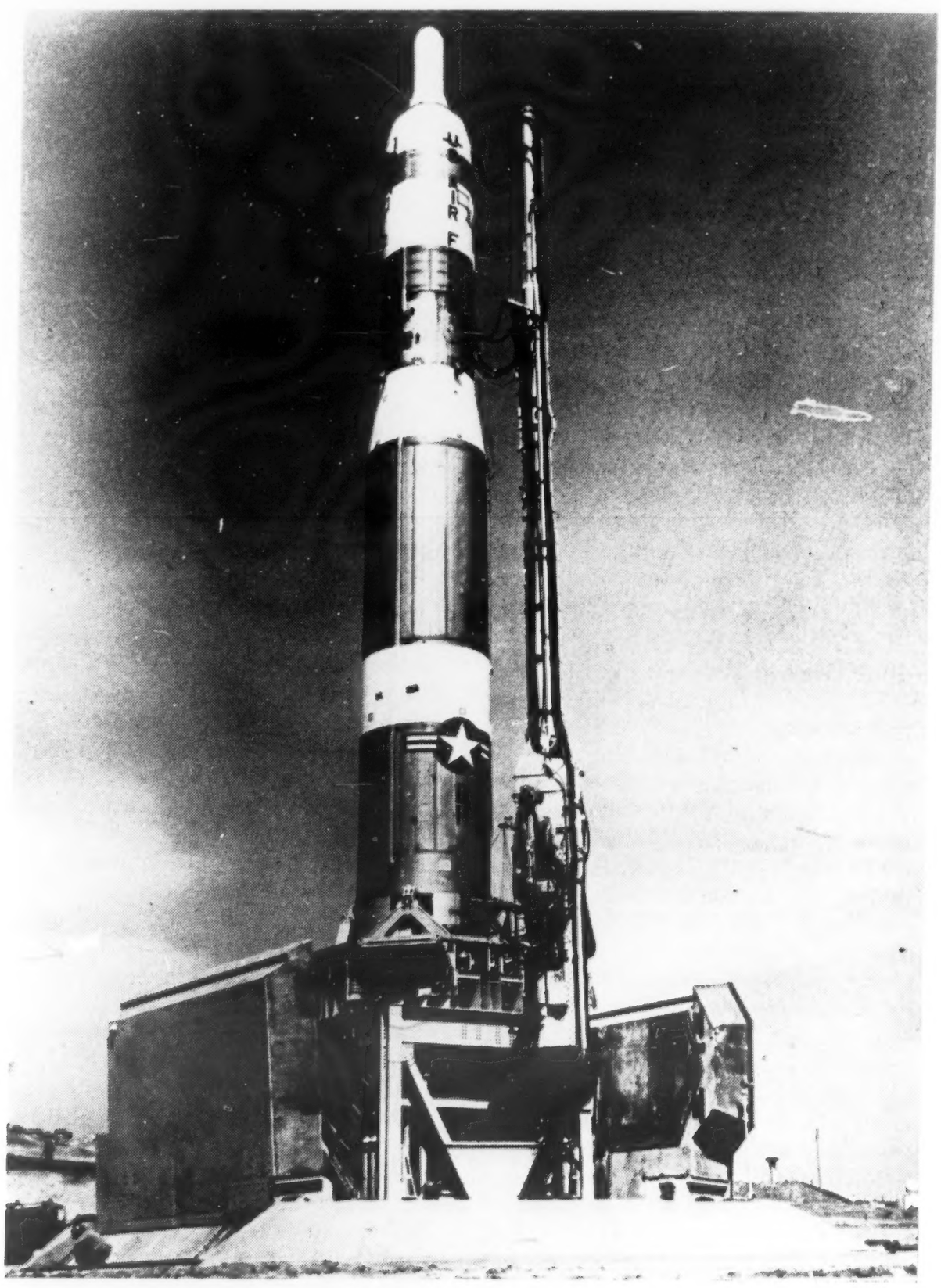
TITAN launching equipment is installed completely underground to provide maximum protection against enemy attack. These underground complexes include launching platforms which lift the ICBMs to the surface for long-distance firing, electronic control centers, guidance antennas, fuel storage and loading systems and the essential interconnecting tunnels which tie the various elements of the launching system together.

The TITAN is the Air Force's second ICBM now being developed and produced for the nation's defense program. It is a two-stage, liquid-propelled missile with a range of at least 5,500 nautical miles at speeds in excess of 17,000 miles per hour. The TITAN was the first ballistic missile to fly successfully on its initial test flight, February 6, 1959.

The first TITAN squadron, near Lowry Air Force Base, Denver, Colorado, should become operational in the summer of 1961.

In addition to this contract, AMF built and installed the original prototype launcher system at Vandenberg Air Force Base, California, where it is presently undergoing tests. AMF is also building, installing and will test the three TITAN training launchers at Vandenberg and the first 18 operational launchers at Lowry Air Force Base.

AMF is an associate prime contractor in the missile support systems field. It is also involved in the study, development and building of launching equipment for the ATLAS, MINUTEMAN and SERGEANT missile programs.



The elevated TITAN ICBM check-out missile shown in firing position in the underground launcher designed and built by American Machine & Foundry Co.

Association affairs

AFCEA

1624 Eye Street, NW
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Phone: EXecutive 3-3033

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1964

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The President, the immediate Past President, the Vice Presidents and the Counsel are ex-officio members of the Board of Directors.
**Executive Committee Member.*

New Chapter at White Sands Missile Range

Under the leadership of Mead S. Arbogast, application for formation of the 52nd chapter in the Association at White Sands Missile Range has been officially submitted to National Headquarters. Seventy-five applications for membership accompanied the application. A proposed Constitution and By-Laws were also submitted for approval of the Executive Committee.

During an organization meeting the following members were elected to serve the group: president. Mead S. Arbogast; 1st vice president. Cantrell M. Daniel; 2nd vice president. Donald H. Roland; secretary, Michael E. Brady; treasurer. Clarence M. Decker.

Colonel W. J. Baird. AFCEA General Manager. has advised the White Sands Missile Range Chapter that official action on their charter application would probably carry the date of July 4, 1960.

Attention Ham Operators

A new AFCEA Ham Radio Directory is being prepared through the courtesy of Ray E. Meyers. Regional Vice President. Region "F." As Ray is interested in listing all AFCEA members who hold a ham license. he has requested that all operators who have not previously forwarded their call letters to do so without delay. An early response will assure your listing.

The form below should be completed and sent to National Headquarters.

Call Letters .....

Name .....

Address .....

Firm or Military Installation .....

Title .....

Business Address .....

☐ Please send me directory.

Signature .....

Visit to Okinawa

The following letter from Benjamin H. Oliver, Jr., AFCEA National President, was sent to Col. Edward C. Coffin, Jr., USA, president of the newly formed Okinawa chapter, upon the occasion of the visit of Henry T. Killingsworth who officially presented the chapter charter.

Dear Colonel Coffin:

It is a very opportune visit that Mr. Henry T. Killingsworth, Vice President of the American Telephone and Telegraph Company and head of all Bell System Long Lines, is making to your Island. He has a very special mission in addition to his normal business in that part of the world, and that is to be our AFCEA Headquarters representive at the meeting during which your chapter's charter will be presented.

I would like to have performed this official act myself or to have had Colonel Baird do so but, because of other pressures of the moment on both of us, it just couldn't work out that way. However, since Okinawa is one of our outpost chapters, it is very appropriate to have Mr. Killingsworth, who heads up a far flung communications system that reaches into all corners of the globe, officiate in our behalf. Since his organization brings man's voice to the nations of the world, it seems very fitting that he bring our Headquarters' voice to your chapter.

Welcome to an organization that is dedicated to a close liaison with communicators in the services and in civilian life, so that they can run in double harness with no delay if our Country has the need for them to do so.

Congratulations on being the 51st Chapter on our roster!

Sincerely.
BENJAMIN H. OLIVER, JR.

AFCEA Convention to Expand in 1961

Due to the tremendous growth of the annual AFCEA Convention, approximately 30 exhibitors who wished to be part of the 1960 show had to be turned down. Many of these refusals pertained to old and established friends and group members of AFCEA. To accommodate this increase and to allow for additional exhibitors for the 1961 Convention, arrangements have been made for the usual 110 exhibits at the Sheraton-Park Hotel, main exhibit hall, and for 120 exhibits in the Shoreham Hotel.

To accommodate an ever increasing audience, arrangements will be made by W. C. Copp and Associates to run

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Challenging career opportunities are available at CBS LABORATORIES on long-range systems development programs such as PHOTOSCAN. Positions for physicists and electrical engineers are now open in the following departments: Military and Industrial Systems; Acoustics and Magnetics; Solid State Physics; and Vacuum Tube Physics.

Please forward resumes in complete confidence, or obtain additional information by contacting CBS LABORATORIES.

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a continuous limousine shuttle bus service between the two hotels, which are just two minutes apart.

A sampling of many of the 1960 Convention exhibitors indicated a preference for this arrangement, rather than having scattered exhibit areas throughout the Sheraton-Park Hotel.

Post Convention Luncheon

Members of the Washington Convention Committee and the staff of National Headquarters were the personal guests of Colonel W. J. Baird, AFCEA General Manager, for luncheon on June 10, at the Army-Navy Town Club, Washington, D. C.

Preceding the luncheon Colonel Baird expressed his thanks and appreciation to the Convention Committee for their outstanding services and assistance in connection with this year's Convention; solicited their suggestions for any improvements; and announced tentative plans for next year.

Members of the Convention Committee attending the luncheon were: William Hulse, Westinghouse Electric Corp.; William C. Copp, W. C. Copp and Associates, New York; John O'Brien, Hoffman Electronics Corp.; Dwight M. Agnew, Washington Associates; Murrey Royar, National Company; A. W. Christopher, Sylvania Electric Products, Inc.; John Gilbarte, Admiral Corp.; W. Earl Trantham, Hughes Aircraft Co.; Joseph R. Redman, Western Union Telegraph Co.; Francis H. Engel, Radio Corporation of America; Percy G. Black, General Telephone Service Corp.

Also present were Convention panel moderators Herbert Rosen, National Aeronautics and Space Administration, and Robert S. Quackenbush, Polaroid Corp. and Derek Scoble, A/2C, USAF, Convention photographer.

Chapter Codes and Totals

The following listing of newly designated chapter codes (found on your membership card) and chapter membership totals is official as of July 1, 1960.

Unassigned	AL	783
Arizona	AZ	106
Atlanta	AT	265
Augusta-Fort Gordon	AG	249
Baltimore	BA	217
Boston	BO	367
Cape Canaveral	CC	44
Central Florida	CF	20
Chicago	CH	594
Cincinnati	CI	51
Dayton-Wright	DW	146
Decatur	DE	163
Fort Monmouth	FM	433
Frankfort	FR	56
Greater Detroit	GD	91
Greater Los Angeles	LA	401
Gulf Coast	GC	163
Hawaii	HA	178
Kansas City	KC	144
Korea	KO	11
Lexington	LE	40
London	LO	214
Louisiana	NO	92

(*Continued on page 64*)

NEW MEMBERS

Listed below are new members of the AFCEA who have joined the Association during the months of May and June. Members are listed under the chapter with which they are affiliated.

Arizona

James J. Lamb
Frank T. Trippi
Norman Osmer
Col. Fred M. Clarke, Jr.
Dr. Paul K. Williams
SFC James W. Drouillard, USA

Atlanta

J. S. Stone
Maston C. Potter
Robert B. Dawson
Glenn D. Henderson
Col. Lynn T. Blake
Brig. Gen. William H. Wise

Augusta-Ft. Gordon

M-Sgt. Pierce E. Glotfelty
Cmdr. Robert L. Corless
SFC Robert D. Dodson
John H. Thias
M-Sgt. J. P. Sikes
James R. Hopkins
M-Sgt. Stephen Zeman
M-Sgt. Lester R. Cooley
Sgt. Homer L. Dukes, Jr.
Joseph M. Galvin
John H. Liberty
Bertrand J. Lemieux
William F. Atwood, Jr.
Jack Ramsey
Thomas L. Cauthen
S-Sgt. Frank O. Martin
Sgt. Frank S. Bonaiuto
M-Sgt. John F. Kane
George L. Holtzinger
David S. Johnson
William G. Arndt
James P. Adams
William W. Cottrell, Jr.
William S. Little
William P. Reid
Frank F. Green
Alvia A. Murdock
Ralph Hargrove
John A. Cook
Ewart S. Dozier
John Danilovich
Robert D. Elijah

Baltimore

Howard T. Nimick
Emil L. O'Neil
John J. Bagliani, Jr.
E. A. King
C. G. McMullen
J. W. Colvin
Hodge Morgan
H. N. Aviles
Henry F. Erfurt
Edward B. Wilford
CWO John R. Dee

Boston

Wallace E. Mackenzie
Russell F. Hoehn
Cdr. Merrill Callum
Robert A. Arnold
Robert Iappini
Robert L. Bobar
Lt. Col. Paul W. Karr
R. Freedman
Capt. John E. Fairbank
George F. Stafford
Capt. Forrest B. Ferguson
Thomas Tranfaglia
Robert W. Boas

Cape Canaveral

William E. Williamson
George W. Tippie
Edward W. Teschke
Warren E. Rogers
Robert L. Owens
Capt. Clarence W. Goldey
Wyendell B. Evans
Waverly S. Brown
Dan W. Cusic
Lt. (j.g.) Walton E. Wells

Central Florida

John E. Hagan

Chicago

Leonard J. Stone
Eric L. Jacobsen
Allan Coleman
Nell Coleman
Edwin W. Ritter
Thomas M. Snow
Vincent A. Ralph
George H. McEwen
Jernon W. Faris
M. L. Devine
R. Borders
K. Hudson
John G. Doyle
James MacRae
Irving D. Liberman
Haskell H. Sumrall, Jr.
Norman A. Stegens
John E. Morgan
W. R. Tatman

Cincinnati

Everett W. Lee
John F. Kilfoil
Ernest J. Clarke, Jr.
Lt. Col. Otis K. Mushrush

Dayton-Wright

Milan G. Filcik
Lucille E. Althoff
Leland C. Dirting, Jr.
J. Thomas Pattison
Gordon T. Yamada
Gerald L. Gibson
William R. Steinberg
Edward W. Stipek
Michael M. Serikaku

Decatur

John T. Reeves

Ft. Monmouth

George C. Hooker
Edith J. Tebo
S. E. Petrillo
Lt. Col. William H. Blatti
Henry J. Tureby
Frank J. McGlinchy
George B. Voorhis, Jr.
2nd Lt. Jon M. Bell
Max E. Meller
Lloyd H. Manamon

Greater Detroit

Charles Lincoln Brady
Robert E. Willingham
Kenneth A. Hazard

Greater Los Angeles

Victor G. Rumbellow
S. M. Wills
Edwin T. Hafford
Chuck Gehrke
Alfred D. Langille
L. R. Everingham
H. M. Watts
Chester J. Piott
Aubrey McKinney
Maurice E. Heidbrink
Jack R. Savage

Gulf Coast

William G. Hogle
Gertrude R. Harding
Wallace B. Fields
Robert W. Grayson
John W. Stephenson
Alonzo O. Bliss, III
1st Lt. Robert L. Wallenmayer

Hawaii

Richard D. Waterman
Thomas R. Lewis
Cdr. Robert B. Greenwood
Cdr. Fred R. Hoeppner
Mrs. M. Kanoe Souza
Maj. Nolan D. Strickler
LCdr. Louis A. Shryack
Maj. John Gregal
Floyd M. Keyes
Clifford S. Yamada
Moses H. Burrows
Capt. Ward F. Hardman
CWO-2 Irving Citron
T-Sgt. Chester L. Wilson
Capt. Marie Lorraine Killwey
Jessie C. Lingle
Willis R. Crowder
Paul E. Wood

Kansas City

George E. Chambers
Marion C. Fach
William H. Massarand
Maj. Richard W. Fox
Maj. Harvey R. Bergman

London

J. F. Hitchcock
Eric A. Taylor
Douglas J. Green
LCdr. Alec R. Gilding
WGCdr. James W. Gale
Maj. James G. Geary
Capt. John Paydo, Jr.

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James S. Law

Montgomery

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George L. White
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Roger W. Hubbell
David C. Flanigan
H. Schubert
Paul J. Larsen
J. Ruston
M. Sullivan
J. A. Regan
R. A. Shea
R. P. Wakeman
John Folinus
Edwin U. DeParma
LCdr. Harold E. Walther
J. E. Dingman
J. H. Felker
Richard E. James
Raymond W. Bristol
C. A. Armstrong
G. Griswold, Jr.
Edward T. McBride
Walter L. Gustavson
John W. Spargo
M. L. Fuchs
J. D. Van Der Veer
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Gordon K. Reynolds
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H. Rapaport

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A. F. Craig
Earl Pollins
Stuart Meyer

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Capt. William G. Dill, Jr.

North Texas

Bill J. Winder
James F. Ranes
William C. Parker
Lester L. Holmes, Jr.
Robert L. Halvorson
Ralph M. Pool
Col. Manuel Fernandez
Dan M. Kirby, Jr.

Northeastern University

Hubert Ernest Holley

Northwest Florida

Harry A. Carl
L. E. Baldwin

Okinawa

Nels W. Willason
Mathew R. Baldwin
John Adler
Gilbert R. Cordero
John E. Bowles
Isamu Higa
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Earle N. Dotson
James W. Tuma
Lt. Col. Sam A. Drewwin
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Walter C. Piemme
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John D. Hicks
William F. Spillane
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Jack C. R. Rillstone
Justin Wentworth
Walter E. Sepp
Robert M. Sternberg
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Edward M. Chrisp
Harold R. Huth
John Holoviak, Jr.
Lt. Col. Alden Van Buskirk
Russel P. Doering
Arnold D. Reicher

Orange

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Fred E. Baetzman, Jr.
James E. Spence, Jr.

Paris

Maj. John E. Mills
Maj. Gen. Robert K. Taylor

Philadelphia

Richard M. Fielding
Jack Searing
Harry Johnson
Fritz Rice
L. Tucker
Joseph M. Hertzberg
M. E. Harris
Lewis Lepofsky
Philip E. Spindell
Theodore B. Aitken
W. A. Scott
T. D. Conrad
A. Louis Charny
M. J. Shapp
Bert Wolf
James Forgey
Harry Jackson
Edward Verner
Brig. Gen. Elmer L. Littell
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Raymond Daly, Jr.

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Raymond T. Herath
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S. L. Utsey
Virginia E. Nugent
Capt. Jesse L. Miller
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Patrick J. Smid
Ursula Arrington
Emelie B. James
John C. Keyser
Thomas P. Nesler
Capt. James R. Sheldon
Arthur D. Watt

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George F. Baldwin
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P. C. Hickerson
E. G. Uhl
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Edwin A. Eastberg

Scott-St. Louis

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Capt. William G. Work
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Fred M. Adler

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Listed below are the firms who are sustaining and group members of the Armed Forces Communications and Electronics Association. By their membership they indicate their readiness for their share in industry's part in national security. Each firm nominates several of its key employees or officials for individual membership in AFCEA, thus forming a group of the highest trained men in the electronics and photographic fields, available for advice and assistance to the armed services on research, development, manufacturing, procurement, and operation.

Sustaining Members

American Telephone & Telegraph Co., Long Lines Department
Cook Electric Co.
General Electric Co., Defense Electronics Div.
International Telephone & Telegraph Corp.
New York Telephone Co.
Western Electric Co., Inc.

Group Members

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Admiral Corp.
Allied Control Co., Inc.
Allied Radio Corp.
American Cable & Radio Corp.
American Institute of Electrical Engineers
American Machine & Foundry Co.
American Radio Relay League
American Telephone & Telegraph Co.
Amphenol/Borg Electronics Corp.
Anaconda Wire & Cable Co.
Andrew Corp.
Arnold Engineering Co.
Associated Electrical Industries Ltd.
Atlas Film Corp.
Atlas Precision Products Co.
Automatic Electric Co.
Automatic Electric Sales Corp.
Automatic Telephone & Electric Co., Ltd.
Autonetics, Division of North American Aviation, Inc.
Barry Controls, Inc.
Beiser Aviation Corp.
Bell Telephone Company of Pa.
Bell Telephone Laboratories, Inc.
Bendix Radio Division, Bendix Corp.
Bendix Systems Division, Bendix Corp.
Bliley Electric Co.
British Thomson-Houston Co., Ltd.
Bruno-New York Industries Corp.
Budd Lewyt Electronics, Inc.
Burroughs Corp.
California Water & Telephone Co.
Cambridge Thermionic Corp.
Capitol Radio Engineering Institute, Inc.
Carolina Telephone & Telegraph Co.
Central Technical Institute
Chesapeake & Potomac Tel. Co.
Cincinnati & Suburban Bell Tel. Co.
Collins Radio Co.
Columbia Broadcasting System, Inc.
Contraves Italiana
Convair, Division of General Dynamics Corp.
William C. Copp & Associates
Copperweld Steel Co.
Cornell-Dubilier Electric Corp.
A. C. Cossor Ltd.
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Decca Navigator Co. Ltd.
Designers For Industry, Inc.
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DuKane Corp.
Du Mont, Allen B., Laboratories, Inc.
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Electronic Associates, Inc.
Electronic Communications, Inc.
Elgin Metalformers Corp.
Fairchild Camera & Instrument Corp.
General Analysis Corp.
General Aniline & Film Corp.
General Communication Co.
General Telephone & Electronics Corp.
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Hallicrafters Co., The
Haloid Xerox Inc.
Hazeltine Electronics Division, Hazeltine Corp.
Heinemann Electric Co.
Hoffman Electronics Corp., Military Products Div.
Hughes Aircraft Co.
Illinois Bell Telephone Co.
Indiana Bell Telephone Co.
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Institute of Radio Engineers
Instruments for Industry, Inc.
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Jansky & Bailey, Inc.
Jerrold Electronics Corp.
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Kleinschmidt Laboratories, Inc.
Leich Sales Corp.
Lenkurt Electric Co.
Ling-Altec Electronics, Inc.
Litton Industries, Inc.
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Marconi's Wireless Telegraph Co. Ltd.
Martin Co., The
Materiel Telephonique Co.
McCoy Electronics Co.
Melpar, Inc.
Michigan Bell Telephone Co.
Montgomery Co., The
Motorola Inc.
Mountain States Telephone & Telegraph Co.
Mullard Ltd.
Muter Co., Rola & Jensen Divisions
Mycalex Corporation of America
National Co., Inc.
Nems-Clarke Co., Div. of Vitro Corp. of America
New England Tel. & Tel. Co.
New Jersey Bell Telephone Co.
North Electric Co.
Northrop Corp.
Northwestern Bell Telephone Co.
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Packard-Bell Electronics Corp.
Page Communications Engineers, Inc.
Phelps Dodge Copper Products Corp.
Philco Corp.
Photographic Society of America
Plessey Co., Ltd.
Prodelin Inc.
Radiation, Inc.
Radio Corporation of America, Astro-Electronic Products Div.
Radio Corporation of America, Defense Electronic Products
RCA Great Britain, Ltd.
Radio Engineering Laboratories, Inc.
Radio Frequency Laboratories, Inc.
Ramo-Wooldridge, Division of Thompson Ramo Wooldridge Inc.
Raytheon Co.
Red Bank Division, Bendix Aviation Corp.
Reeves Instrument Corp.
Republic Aviation Corp.
Rixon Electronics, Inc.
Rocke International Corp.
Ryan Aeronautical Co.
Saxonburg Ceramics, Inc.
Scanner Corporation of America, Inc.
Servo Corporation of America
Singer Manufacturing Co., The Military Products Division
Smith-Corona Marchant Inc., Research and Development Division
Society of Motion Picture & Television Engineers
Southern Bell Telephone & Telegraph Co.
Southern New England Telephone Co.
Southwestern Bell Telephone Co.
Sperry Gyroscope Co., Division of Sperry Rand Corp.
Sprague Electric Co.
Stackpole Carbon Co.
Standard Electronics Co.
Standard Telephones & Cables, Ltd.
Stanford Research Institute
Stewart-Warner Corp.
Stromberg-Carlson Co., Division of General Dynamics Corp.
Surprenant Mfg. Co.
Sylvania Electric Products, Inc.
Technical Materiel Corp., The
Telectro Industries Corp.
Tele-Dynamics Div., American Bosch Arma Corp.
Telephonics Corp.
Teleprinter Corp.
Teletype Corp.
Texas Instruments Incorporated
T.M.C. (Canada) Ltd.
Tung-Sol Electric, Inc.
Union Carbide Corp.
United Telephone Co.
United Transformer Co.
Varian Associates
Waterman Products Co., Inc.
Webcor, Inc., Government Division
West Coast Telephone Co.
Western Union Telegraph Co.
Westinghouse Electric Corp.
Westrex Corp., a Division of Litton Industries, Inc.
Wheelock Signals, Inc.
Wilcox Electric Co., Inc.
Wisconsin Telephone Co.
Wollensak Optical Co.
Zenith Radio Corp.

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Chapter News

Augusta-Fort Gordon

A barbeque was held in May to raise money for the Awards Fund. Each year a monetary award is made by the chapter to the outstanding science student graduating from a high school in the Central Savannah River Area.

This year the award was made to Harry Suber, from the Aquinas High School. Payment of $300 will be made by the local chapter to Clemson College toward his first year tuition. Jack Ramsey and Thomas L. Cauthen were runners-up.

The award was presented at the final meeting of the season, a dinner-dance at the Fort Gordon Officers Open Mess, June 16. Francis A. Saxon, new chapter president, was introduced at the meeting. Outgoing president, Lt. Col. Fred J. Frank is being transferred to another station.

Baltimore

The regular monthly dinner-meeting was held May 17, at the U.S. Marine Corps Training Center, First Engineering Battalion USMCR. Guest speaker Maj. Gen. James Dreyfus, Director of Communications-Electronics, Joint Chiefs of Staff, Office of the Secretary of Defense, spoke to the 65 members and guests attending.

J. Walton Colvin, chapter president introduced the head table guests who were: Lt. Col. James M. Joyner, commanding officer of the USMCR Training Center, and Mrs. Joyner; Col. J. T. Bradshaw, Hdqrs. USMC, Chief of Communications and Electronics; Col. Robert F. Frost, Office of the Joint Chiefs of Staff, and Mrs. Frost; Capt. J. A. Skinner, in charge of Shore Communications, and Mrs. Skinner; Mrs. J. Walton Colvin; Maj. Gen. James Dreyfus and Mrs. Dreyfus; George C. Ruehl, Jr., regional vice president, AFCEA; Cdr. Bob Kirsten, newly elected president of the chapter, and Mrs. Kirsten; Trevor H. Clark, chairman of the board of the chapter; Mrs. John A. Shipley, recording secretary of the chapter.

Gen. Dreyfus spoke on Military Communications, which is receiving public attention with the "increasingly large 'bite' of the defense budget being consumed by the communications-electronics area." He pointed out that "the identifiable communications-electronics procurement for next year exceeds one billion dollars for the three services. The present capital investment in fixed communications for the three military departments exceeds one billion dollars. . . . The vast long-line communications services that have efficiently handled the several military departments communications requirements for many years are being molded into a single integrated long-line system for the Dept. of Defense."

He said, "One thing the service communicator has to watch at all times is that the desire for economy does not bring about a degradation of the service."

Chicago

The May 26 meeting was held at the Electronics Supply Office, Great Lakes, Ill. Capt. Robert H. Northwood, commanding officer of the Electronics Supply Office and a director of the chapter, was host for the evening.

Prior to the dinner-meeting "Nautilus Under the North Pole," a movie describing the voyage of the famed submarine, was shown. Capt. Edward J. Fahy, assistant chief of the Bureau of Ships for Design and Research, Navy Dept., was the featured speaker. His talk, "Fighting Ships and Modern Electronics," outlined technological advances made by the Navy in the field of electronics since World War II for both surface ships and submarines.

Another special event of the evening was a musical program by the world famous Bluejacket Choir of the U.S. Naval Training Center, Great Lakes.

Decatur

The meeting May 31 was held in the Officers Mess of the Decatur Signal Depot. After the business meeting two films, "Sounds Familiar" and "Horizons Beyond," were shown.

Greater Los Angeles

The election of officers and a guest speaker highlighted the May 11 meeting held in the Golden Room of the Statler-Hilton Hotel. Guest speaker was M. T. Johnson, vice president, Security First National Bank. His talk, "Business in 1960 Will Be Good for the Good Businessman," pointed up the signposts looked for by major financial institutions in analyzing the potential of electronic and missile industrial firms.

Honored guest was Mid-shipman Dennis Rathbun, NROTC, University of Southern California. The AFCEA Gold Medal award was presented to him by James Russell during a special ceremony on May 24 for his work in electronics engineering.

Officers for 1960-61 are: president, John W. Atwood, Hughes Aircraft Co.; 1st vice president, Ray E. Meyers, Lockheed Aircraft Corp.; 2nd vice president, Frank J. Shannon, Packard Bell Electronics Corp.; secretary, Joseph H. Goodrich, Pacific Telephone & Telegraph Co.; treasurer, Jay DeBeau, Radio Corporation of America.

Directors for 1960-61 are: John W. Inwood, Western Union Telegraph Co.; James G. Russell, Librascope, Inc.; John K. Knight, National Broadcasting Co.; David G. Soergel, North American Aviation, Inc.; John F. Byrne, Motorola, Inc.; Thomas L. McKnight, Glenair, Inc.; Charles A. LaHar, Radio Corporation of America; Charles McGuigan, Western Electric Instrument Co.; Leonard D. Callahan, Gilfillan Brothers, Inc.; Lester R. Daniels, Turbo Dynamics Corp.; Richard Fuller, Bendix Pacific; Loyd C. Sigmon, Golden West Broadcasters.

John W. Inwood, Charles F. Horne, C. E. Kirk, Jr. and Ray E. Meyers were elected National Council members.

Fort Monmouth

A salute to the Army Signal Corps was given at the May Signal Corps Centennial dinner-meeting held at Gibbs Hall Officers Club. Special guests included State Senator and Mrs. Richard R. Stout, Monmouth County Freeholder Director Joseph C. Irwin and Mrs. Irwin and Col. William Blair, USA (Ret).

To celebrate the Signal Corps Centennial, after-dinner talks on its past, present and future were given by Maj. Gen. Herbert L. Scofield, Chief of the Procurement and Distribution Division, Office of the Chief Signal Officer, Washington, and Dr. George Raynor Thompson, Chief of the Signal Corps Historical Division, Washington, D. C.

As an added feature, six enlisted men in costumes representing the Civil War, Spanish-American War, World Wars I and II, Korea and the present, told about equipment and experiences of the periods they represented. Another representing the American Indian, in full regalia, was also a member of the Centennial group.

Harry C. Ross, chapter secretary, was toastmaster for the evening.

Gulf Coast

The regular dinner-meeting was held June 6, at the Broadwater Beach Hotel in Biloxi, Mississippi. Ancil Arseneau presided over the meeting in the absence of Lt. Col. George S. Walborn, chapter president.

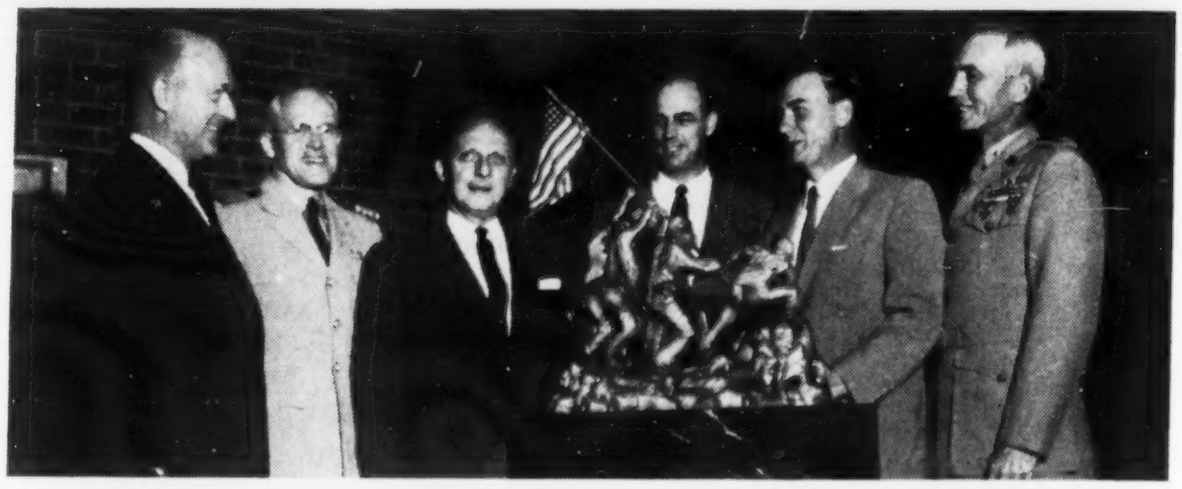
Jack Heckelman, Philco Corporation, was guest speaker to the 87 members and guests. He gave an illustrated talk on the USAF AIRCOM Modernization Program, "Quick-Fix," showing the latest in new developments, techniques, and equipment in improving our world wide communications.

Kansas City

Maj. Gen. W. W. Bowman, Commander of the 33rd Air Division, was guest speaker at the June dinner-meeting held at the Richards Gebaur Air Force Base Officers Club. John R. Parsons, division manager, Southwestern Bell

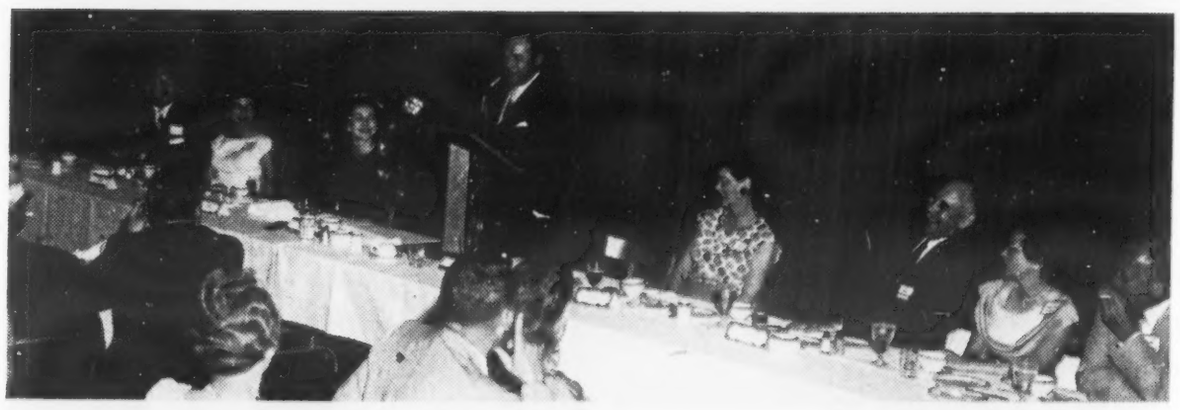
(*Continued on page 55*)

Augusta-Fort Gordon—Members of the committee which planned the successful fund raising barbecue held in May are. L to R, John Myers, Jewette Harris, Goat Saxon, George Norman and Lt. Col. Fred J. Frank.



Baltimore—Pictured at the May meeting of the chapter are, L to R: George C. Ruehl, Jr., AFCEA Regional Vice President; Capt. J. A. Skinner; Major General James Dreyfus, guest speaker; Cdr. Bob Kirsten, USCG, newly elected chapter president; J. Walton Colvin, chapter president; Lt. Col. James M. Joyner, USMC. This picture was taken by Mrs. John A. Shipley, recording secretary of the chapter.

Greater Los Angeles—Shown at left is past president, John W. Inwood congratulating newly elected 1960-61 president John W. Atwood. Also pictured is Midshipman Dennis Rathbun, NROTC, University of Southern California, Gold Medal Award Winner and Frank T. Shannon, 2nd vice president.

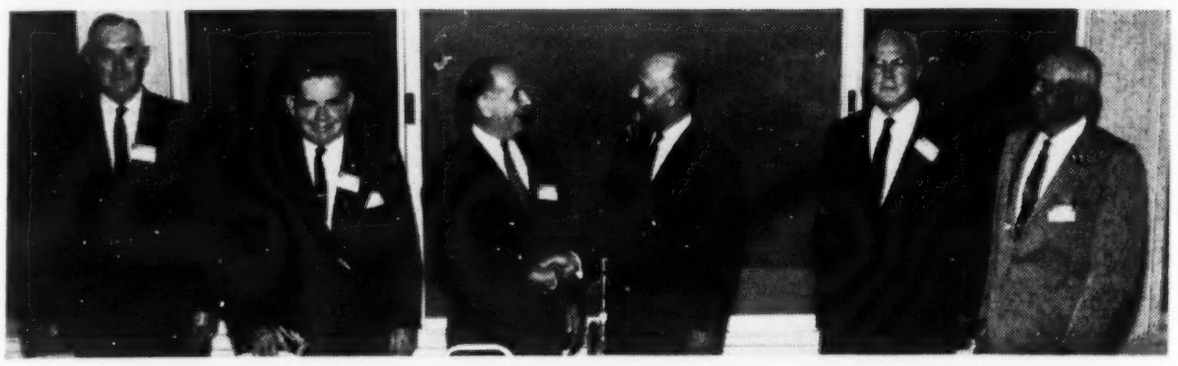


Kansas City—Head table guests at the June meeting, L to R: C. E. Sevier, Mrs. C. E. Sevier, Mrs. W. W. Bowman; William J. London, chapter president, hidden by Gen. Bowman; Maj. Gen. W. W. Bowman, guest speaker; Mrs. London; Lt. Col. G. D. Meserve; Mrs. M. H. Tyrrell; M. H. Tyrrell.

Montgomery—Seated at the head table at the May meeting are, L to R: Mrs. Sidney W. Reese, wife of Southern Bell Telephone & Telegraph Company's Alabama Chief Engineer; William Keister, Bell Laboratories, director of Switching Engineering, guest speaker for the occasion; Mrs. Herbert Herman; Lt. Col. Herbert Herman, chapter president; A. B. McFerren, vice president.

Paris—Rear Admiral H. C. Bruton, USN, standing, was guest speaker at the June meeting. Also pictured from left of RAdm. Bruton are Mrs. M. J. H. Ponte, Maj. Gen. F. W. Moorman, R. Lucas, Dr. M. E. Doloraine Dr. M. J. H. Ponte, Mrs. F. W. Moorman.

Rocky Mountain—Pictured at the May meeting are, L to R: Mr. Hudgins, Mountain States Telephone & Telegraph Co., vice president, Operations; C. S. Ray, Mountain States Telephone & Telegraph Co., assistant vice president, Defense Communications; Mr. McAdams, Hq ADC; Walter Koch, Mountain States Telephone & Telegraph Co., president; Mrs. Hudgins; Mr. W. E. Burke, Western Electric Co., vice president, Defense Products Division, guest speaker.



Santa Barbara—Pictured at the joint meeting held May 6, are L to R: Hart Bellinger, president, Retired Professional and Business Men's Club; Lt. Cdr. Ray E. Meyers, USN (Ret.), AFCEA regional vice president, guest speaker; RAdm. C. C. Ray, USN (Ret.), president AFCEA Santa Barbara chapter; Mayor Edward L. Abbott of Santa Barbara; Cdr. William F. Kurfess, USN (Ret.), commander, Santa Barbara chapter, Military Order of the World Wars; William S. Porter, Chaplain, Retired Professional and Business Men's Club.

Chapter News

(Continued from page 53)

Telephone Co., Western Missouri Division and Lt. Col. G. D. Meserve, USAF (Ret.) were also special guests.

Gen. Bowman spoke on the Air Defense Command and the roll it plays in the defense of the North American continent. He described the possible effects an all out nuclear attack would have on any continent of the world.

New York

The chapter had its annual June party at the Officers Club, Governors Island on June 15. It was a farewell party for Col. William Jennings, Signal Officer, First Army.

Northwest Florida

Forty-one members and guests of the chapter gathered on May 20 at the El Conquistador Restaurant, Pensacola Beach, Florida for a dinner. Guest speaker was Dr. Dietrich E. Beischer, head of the Department of Bio-Chemistry at the U.S. Naval School of Aviation Medicine, Pensacola.

Dr. Beischer spoke on "Environmental Conditions in Space." He showed a film and explained the intent of the Project Mercury Program. He also explained the effects upon manned flight of the Van Allen radiation belts, which were discovered during the International Geophysical Year, and the behavior patterns and other psychological and physiological data that men and animals have encountered in simulated space flights.

Paris

The last meeting for the 1959-60 season was held at the Pavillon Dauphine with 85 members and guests attending. Chapter president, RAdm. Henry C. Bruton, Director Communications-Electronics Division, Headquarters, European Command, delivered a talk on Nuclear Submarines. The talk was followed by a film showing a trip of the Nautilus under the North Pole.

Maj. Gen. F. W. Moorman, Chief Signal Officer SHAPE was elected as the new chapter president for the 1960-61 season.

Rocky Mountain

The May 18 dinner-meeting at Continental Denver Hotel, Denver, Colorado concluded the 1959-60 formal program for the chapter. Mr. Walter Koch, president, Mountain States Telephone and Telegraph Co. was among the honored guests present.

W. E. Burke, vice president, Defense Projects Division, Western Electric Co., presented a program on Project Mercury to the 77 members and guests.

June 11, members and their guests attended a picnic.

San Diego

The chapter met in the auditorium of Convair on May 18. The program for the meeting was presented by Robert E. Honer, Manager of Electronics, Convair. He spoke on the structure and areas of interest of Convair electronics and showed a color film on "Convair Electronic Facilities."

Also included was a film on the Convair 880 jet aircraft and a tour of the area where this new aircraft was seen in various stages of assembly.

The following officers were elected prior to the program: president, Capt. John H. Allen, USN, Deputy Director, Navy Electronics Laboratory; first vice president, George E. Pearson, Head of Patents, Rohr Aircraft Corp.; second vice president, William R. Rauth, Manager of Electronic Marketing, Convair; secretary, Paul Vasquez, Market Anal-

(Continued on page 64)

NEWS ITEMS AND NEW PRODUCTS

The Japanese Ministry of International Trade and Industry (MITI), has modified the ban on export licenses for radios with three or more transistors destined for the U.S., Canada and Puerto Rico, according to information received from the U.S. Embassy in Tokyo by the Electronics Division, Business and Defense Services Administration, U.S. Department of Commerce. The step reportedly was taken to avoid financial hardship to exporters.

MITI announced on May 23 that licenses on such exports would be permitted provided they met all of the following requirements: contract concluded and letter of credit or other financial payment arrangements completed by May 9; export shipment to be completed by May 31: and, export request in keeping with 1959 level of individual exporter.

This action followed MITI's suspension of export licenses to the three markets effective May 10. Estimates of Japanese trade sources indicated that export applications for shipments to Canada and the U.S. on that date ranged from 700,000 to 800,000 receivers.

• • •

Successful demonstration of a phenomenon in the physics of hot gases has been announced jointly by the Air Force Office of Scientific Research and Litton Industries.

A series of experiments on gas plasmas were performed with the aid of an electromagnetic plasma accelerator which, at present, is mainly intended to advance knowledge in the control of hot, ionized gases and to provide basic information upon which the design of future propulsion systems can be based.

Electromagnetic fields in the device act on a gas in such a manner as to convert it into a conductor of electricity and to form it into a doughnut-shaped "plasmoid" which is trapped and accelerated at extremely high velocities within the fields. Acceleration takes place in a direction perpendicular to the plane of the plasmoids and is accomplished without the loss of the plasmoid shape.

Litton scientists explain that this is equivalent to making a smoke ring and propelling it at speeds in excess of 250,000 miles an hour without distorting the shape of the ring. The gas "doughnuts" have been photographed while emerging from the experimental device.

The techniques employed in the formation and acceleration of the plasmoids are original with Litton scientists who indicate the new method eliminates the problems of electrode erosion, wall friction and low efficiency in the development of plasma space propulsion systems. Litton scientists believe it should be possible soon to accelerate gases to a sizable fraction of the velocity of light.

• • •

Aeronutronic, a Division of Ford Motor Company, Newport Beach, Calif., has developed a small electronic "neuron" which artificially duplicates portions of the human nervous system and carries out learning processes.

The electronic "neuron," called MIND (Magnetic Integrator Neuron Duplicator), is about a fourth the size of a penny and is composed of a magnetic core with an inner hole through which wires are strung. The ceramic (magnetic) core is capped with a metal washer and again wound with wires.

The device is modeled after the synaptic junction found in human and animal nervous tissue. This junction is a relay point for passing signals from one nerve cell to another. The synaptic junction is like a door which enables someone or something to pass from one room to another, then closes to prevent others from entering. The synaptic junction selectively passes certain signals from one nerve cell to another. Aeronutronic's neuron-like device, like a living cell, can remember experiences and learn new facts under control of a human or mechanical teacher.

The artificial "neuron" stores or remembers the effects of past events by increasing or decreasing the amount of flux stored in a magnetic circuit. Memory contents are read simultaneously at electronic speeds from a series of similar artificial neurons. In this way, the sum total of past experiences controls the decision of response made by a network of MIND elements.

Transistor circuits are used in conjunction with the MIND to help it carry out decision-making functions. During tests, the MIND has learned the rules for giving correct answers in coded language in response to a limited number of electronically stated problems.

Aeronutronic is considering building a larger artificial nerve-set for testing behavior in more complex learning situations. Development work on the unit was supported by the Office of Naval Research Information Systems Branch, Washington, D. C. and the U.S. Air Force's Rome, N. Y. Air Development Center.

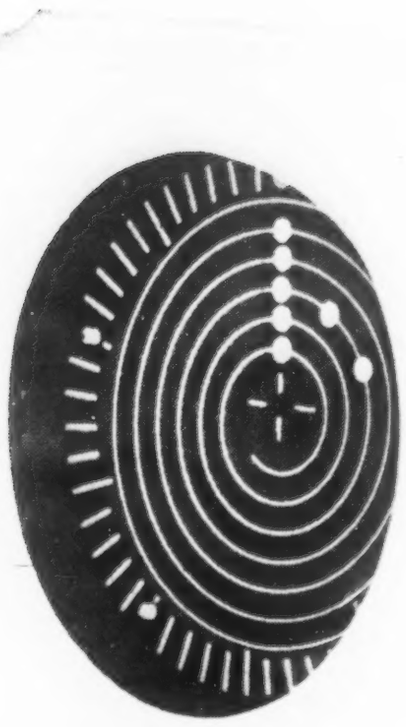
The MIND was developed by Aeronutronic for the Perceptron Program. Perceptron is a model of portions of the nervous system devised at Cornell Aeronautical Laboratory, Buffalo, N. Y.

• • •

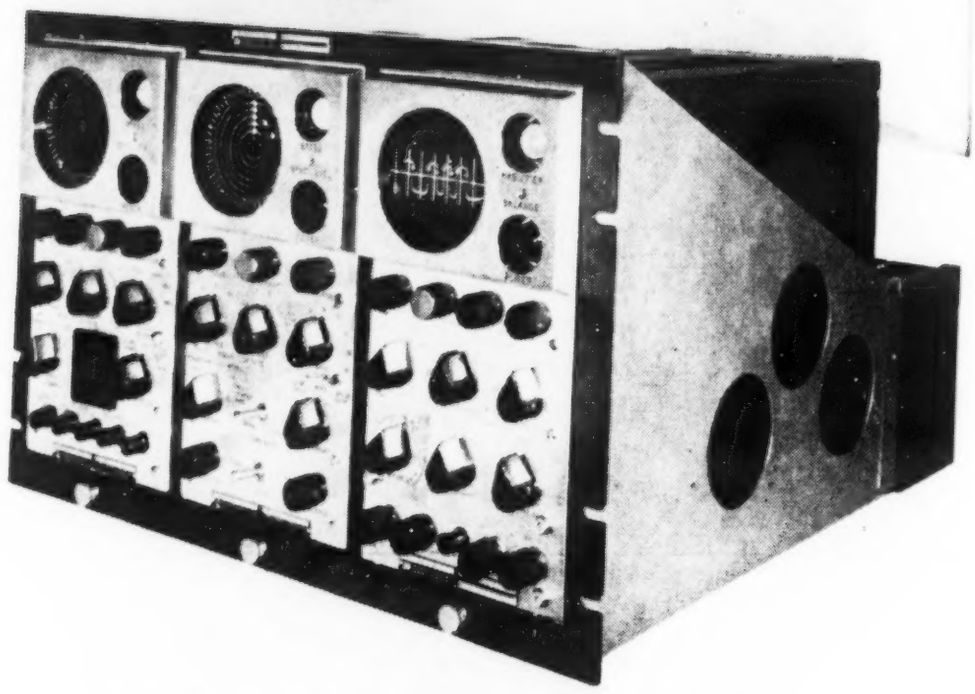
A new technique for the study of superconductivity permits direct visual observation of transformations between the normal and superconductive states. The experimental method, developed at the General Electric Research Laboratory in Schenectady, N. Y., employs a combination of magnetic and optical effects to achieve direct visual observation.

The method is based on the fact that a sufficiently strong magnetic field can change a material from superconducting to normal, but so long as the material remains superconductive it is a perfect magnetic insulator. The specimen to be observed is usually prepared in the form of a flat disc or plate, although thin, vacuum deposited films have also been studied in this manner. On top of the sample a plate of a special cerium phosphate glass about one hundredth of an inch thick is placed. When magnetized, this glass has the property of rotating the plane of polarized light. Monochromatic polarized light is beamed on the glass and the reflected light is viewed through a polarizing filter which can be rotated to any desired angle.

The material under study is customarily cooled in liquid helium to a temperature of about 1.5° above absolute zero. At this temperature it is superconductive, but it can be changed back and forth between superconductive and normal by varying a magnetic field. At certain magnetic field strengths, the specimen is in the intermediate state, with por-



WHAT'S WRONG WITH THIS TELEGRAPH SIGNAL?



...and how do you find out without interrupting traffic?

The answer to the second question is Radiation's TDMS—Telegraph Distortion Measurement System—a compact, self-contained unit for on-line testing, analysis and monitoring of telegraph and data transmission links.

The TDMS detects, measures and analyzes signal distortion on a continuous basis, alerts even a non-technical operator that a circuit is deteriorating. Thus pinpointed, the malfunction (a badly-tuned receiver in a radio link, for example) can often be corrected with little or no circuit downtime.

For detailed information on the TDMS, write for Bulletin RAD E-100B to Radiation Inc., Melbourne, Fla. Address Dept. S-8

WHAT'S WRONG WITH THE SIGNAL SHOWN ABOVE? Character (letter R) shows a split 4th element, a result of poorly adjusted transmitting equipment. Spiral trace display on Telescan CRT (at left) indicates the presence, and analyzes the nature of characteristic distortion.

THE ELECTRONICS FIELD ALSO RELIES ON RADIATION FOR...

RADIPLEX–50-channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

RADICORDER–Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisition or processing systems. Eliminates necessity of electronically translating complete data, thereby reduces computer work loads.

TELEMETRY TRANSMITTER–Model 3115 is a ruggedized 215-260 MC unit with extremely linear FM output under the most severe environmental conditions. With its record of outstanding performance in many missile programs, Model 3115 is specified by leading missile manufacturers.

RADIATION INCORPORATED

tions of it normal and portions superconductive.

Since the superconductive areas shield the portions of the glass plate directly above them from the magnetic field, these parts of the glass are not magntized. But portions of the glass directly above normal areas in the sample are not shielded and are thus magnetized. The parts of the glass that are magnetized rotate the plane of polarized light they reflect, while the parts that are shielded do not. By adjusting the polarizing filter through which the reflected light is observed, the magnetized portions of the glass can be made to appear dark and the unmagnetized portions light, or vice versa. Since this pattern of light and dark corresponds exactly to the pattern of superconducting and normal metal in the sample, changes in the state of the sample can be observed and photographed directly.

The technique, which was developed by G.E.'s Dr. Warren De Sorbo from an approach originally used at the Naval Research Laboratory, has produced information on the motions of normal and superconducting "domains" which could not be observed before. It is also a quick and accurate method of measuring certain basic magnetic properties of superconductors.

• • •

The Sperry Phoenix Company has developed a radar system capable of automatically controlling and guiding the descent of manned or unmanned spacecraft and landing them by remote control.

The system consists of a single ground control radar unit, housed in a specially constructed highway van, and transponder equipment located in the spacecraft to receive and transmit coded radar signals. The spacecraft follows a radar beam from the edge of space to the landing site. A ground radar scanning antenna atop the van locks onto the descending vehicle and automatically tracks its flight. Electronic computers calculate the best approach heading and transmit signals aloft which are automatically translated into "how to fly" information for the craft's automatic flight controls. These components make it possible to revise a flight plan at any time.

Throughout the high-speed earth-approach glide, the system automatically issues corrective commands based on information being received from instruments within the spaceship. As the landing area is approached a ground controller commands a flare-out while the system automatically tracks the ship through the touchdown and ground roll.

A single radar frequency band is employed in all the system's tracking, guiding and data transmitting functions. Using a pulse code modulation technique, the automatic ground controls fire coded questions, receive answers and issue commands to the spacecraft at the rate of 5,000 pulses per second.

The basic system has been perfected by Sperry for the U.S. Air Force as a universal means of controlling very advanced drone aircraft and missiles. Its first scheduled application is to provide remote control of these vehicles for realistic air defense tests against the most modern long-range air weapons.

• • •

Free radicals—molecular fragments known to possess high energy potential—are being produced in a seemingly self-sustaining system by Energy Conversion Laboratories (ECL) of Detroit. The natural atomic reactions of the highly reative particles are being controlled at near room temperature and their chemical energy is being converted directly into electricity and other forms of power according to ECL.

ECL reports the basic principles involved and end results obtained have been successfully and repeatedly demonstrated by various laboratory tests. No plans as yet have been made for commercializing the conversion system. However, according to Stanford R. Ovshinsky, inventor-founder of Energy Conversion Laboratories, analysis of experimental data obtained from present working models suggests the possibility of adapting the phenomena to self-contained packaged power units capable of being started and operated continuously without moving parts and in a manner entirely independent of conventional power sources.

• • •

Development of a high-power microwave switch that can be closed in tenths of a microsecond has been announced by Sylvania Electric Products, Inc.

The microwave switch uses a gas discharge, similar to that in a thyratron, to create a fast acting and relatively high-power switch for a microwave line. In addition to closing in tenths of a microsecond, the switch can be reopened in a few microseconds.

Sylvania scientists Dr. Rudolph Hutter, Dr. Robert Hill and Steven Ichiki presented a technical paper describing the new switch before the International Congress on Microwave Tubes held in Munich, Germany last June. The switch was reported to be faster than present devices, including ferrites, which perform similar switching functions.

• • •

Raytheon Company has developed an electronic computer converter that pours out two and one-half million samples of information per second.

The converter is less than a cubic foot in size and uses a Raytheon technique to convert an analog or continuous signal into digital or number form for processing by a digital computer.

Among other tasks, the converter-computer combination can measure stress or strain of an airplane wing. As the wing stretches under strain, a "pick-off" device gives off analog signals which are then converted into usable form.

Raytheon reports the converter's accuracy is high and that advanced converters can be designed to handle 10 million samples of data with an accuracy of one-half percent of full scale.

• • •

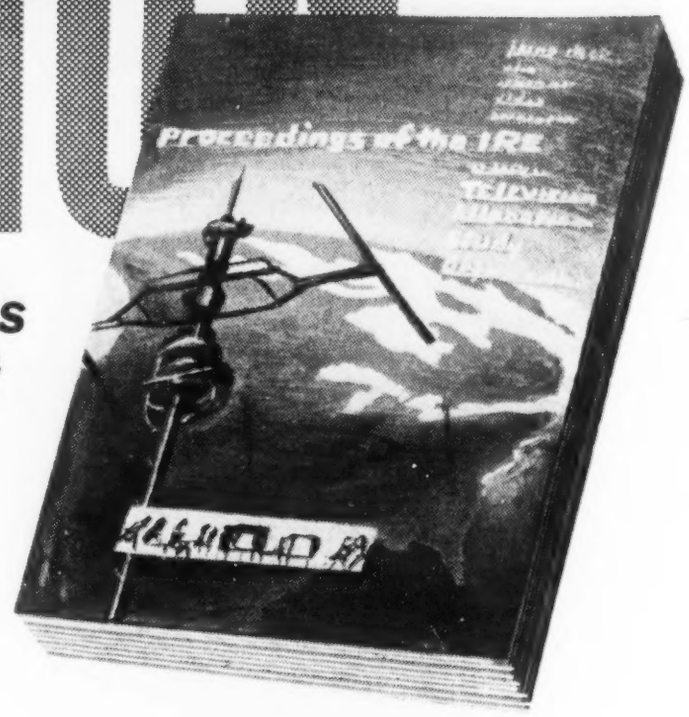
The May 15, 1960 issue of *France Actuelle* carries comments on French research and invention by G. N. Robillard, a retired U.S. Navy Captain and former Assistant Chief of Naval Research (Patents) from 1947 to 1951 and again from 1955 until 1959. Robillard recently spent seven weeks in France talking with industrial, research and patent personnel.

". . . French achievements in the electrical field are well known, and France's scientists and engineers are making great strides in the electronics field. One extremely interesting invention of Cometa of Grenoble is a contractor actuated by a photoelectric cell. The entire device is extremely small, and is of such rugged construction, that it can be readily installed in the open. It is being extensively used throughout France for the control of outdoor lighting systems and is also in extensive use in England. In the related electronics field, The Société Altic has invented and placed into operation a device for controlling the winding of extremely thin threads such as are used in the making of miniature electronic parts. By the utilization of this device one manufacturer reduced his wastage from 20 percent to less than one percent.

"Among the many other inventions was a chromonizing process wherein the chrome so deeply penetrates the

TELEVISION

The Principal TASO Findings on



June PROCEEDINGS *presents an exclusive report of world-wide significance*

IRE is proud to present, in June 1960 Special Issue of PROCEEDINGS, the findings of a team of 271 engineers who for 2½ years conducted studies of world-wide significance for the future of television. The *Television Allocations Study Organization* — formed by the TV industry in 1956 at the FCC's request — has exhaustively analyzed the engineering factors underlying allocation of frequencies for VHF and UHF television broadcasting.

As the number of television services grows, a better use of TV channels becomes increasingly important. TASO engineers first drew up specifications for measuring TV field strengths; then sifted data on field strengths of VHF and UHF. They have discovered reasons for hitherto unexplained deviations, and have also sought to establish a relation between field strength and picture quality.

How good are directional TV transmitting antennas? The results of extensive field tests are analyzed. To what extent do interfering signals and noise affect picture quality? How accurately can one predict an interfering field? These and other questions are answered.

So important are the TASO findings that IRE has allocated 120 pages to them. If you are not already an IRE member, we suggest you send in the coupon below to reserve a copy, for the June 1960 PROCEEDINGS will surely remain the definitive work on VHF and UHF TV for many years to come.

List of contents:

BE SURE YOU READ THESE ARTICLES!

"Television Allocations Problems" by E. W. Allen, Federal Communications Commission

"The Television Allocations Study Organization"—a Summary of its Objectives. Organization and Accomplishments" by George R. Town, exec. dir. of TASO; Iowa State University

"Measurement of Television Field Strengths in the VHF and UHF Bands" by H. T. Head, A. D. Ring and Associates; and Ogden L. Prestholdt, CBS-TV

"Forecasting Television Service Fields" by Alfred H. LaGrone, University of Texas

"Influence of Trees on Television Field Strengths at Ultra-High Frequencies" by H. T. Head

"Tropospheric Fields and their Long-Term Variability as reported by TASO" by Philip L. Rice, National Bureau of Standards

"Picture Quality—Procedures for Evaluating Subjective Effects of Interference" by G. L. Fredendall and W. L. Behrend, RCA Labs.

"Measurement of the Subjective Effects of Interference in Television Reception" by Charles E. Dean, Hazeltine Research Corp.

"Studies of Correlation between Picture Quality and Field Strength in the United States" by C. M. Braun and W. L. Hughes, Iowa State University

"Relative Performance of Receiving Equipment as reported by TV Servicemen" by Holmes W. Taylor, Burroughs Corp.

"VHF and UHF Television Receiving Equipment" by William O. Swinyard, Hazeltine Research Corp.

"Findings of TASO Panel I on Television Transmitting Equipment" by H. G. Towlson of General Electric Co. and J. E. Young, RCA

"Determining the Operational Patterns of Directional TV Antennas" by F. G. Kear, of Kear and Kennedy, and S. W. Kershner, of A. D. Ring and Assoc.

"Sound-to-Picture Power Ratio" by Knox McIlwain, Burroughs Corp.

"Presentation of Coverage Information" by D. C. Livingston, Sylvania Electric Products, Inc.

"The Television System from the Allocation Engineering Point of View" by Robert M. Bowie, Sylvania Research Labs.

THE INSTITUTE OF RADIO ENGINEERS
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☐ Enclosed is $3.00.

☐ Enclosed is company purchase order for the June, 1960 issue on Television.

All IRE members will receive this June issue as usual. Extra copies to members, $1.25 each (only one to a member).

Name .....

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metal that a cross sectional view makes it appear that the interior metal has been poured into a shell of chrome. . ."

France Actuelle is a fortnightly report for Americans on modern France and the French Community. It is published by the Comité France Actuelle, a private association of French businessmen.

• • •

Design engineers at Lear Inc., have developed a compact servo amplifier.

The amplifier is contained in a package with a total volume of less than a cubic inch. Packaging techniques include a nearly cubical shape for optimum use of volume, three-dimensional component-stacking, ultra-thin and flexible printed circuitry and subminiature silicon transistors.

In addition to its small size, the amplifier features a choice of phase shift characteristics (eliminating the need for external capacitors); externally adjustable gain; and, low output impedance with respect to load impedance. The unit has passed Military Specification MIL-E-5272 covering temperature, altitude, shock, vibration and humidity extremes. It performs throughout a temperature range of from −55°C to 100°C and can withstand 10 G's up to 500 cycles per second. For further information, contact J. A. Andrews, Lear Inc., Box 688, Grand Rapids, Michigan.

• • •

All members of the Association and their families are urged to exercise their voting rights on Armed Forces Voting Day, designated September 27, 1960 by the Secretary of Defense.

Latest information on all election laws and dates has been distributed to all military personnel. Armed Forces Voting Day will constitute a maximum effort to insure that all citizens defending our American heritage will have the opportunity to cast an effective ballot.

• • •

The famous television tape recording of the Moscow debate between Vice President Richard Nixon and Soviet Premier Nikita Krushchev became a permanent part of U.S. history recently when Ampex Corporation presented its original VIDEOTAPE recording of the event to the U.S. Library of Congress.

In ceremonies at his office, Nixon accepted the historic tape on behalf of the Library from Phillip L. Gundy vice president of Ampex Corporation, developers of the VIDEOTAPE television recorder. The gift was then turned over to L. Quincy Mumford, Librarian of Congress.

The recording of the impromptu verbal exchange was made on July 24, 1959 during a visit of Nixon and Khrushchev to the American National Exhibition in Moscow's Sokolniki Park. Gundy immediately rushed the tape to this country where less than 36 hours later it was broadcast by all networks to an estimated 75 million viewers. It was also seen in Russia, the United Kingdom, Canada and other countries.

The tape will become part of the audio-visual collections of the Library where it will be available for use by future historians and scholars.

• • •

Sperry Gyroscope Company has developed a new microwave tube, a multimegawatt amplifier that boosts output power of military radars 5000 times for more precise tracking of missiles at longer ranges.

The tube's short wavelength, half as long as in earlier super-power tracking systems, provides sharper beams for pinpointing small missiles. Mid-section of the tube employs a 100-ampere electron beam to generate 3,000,000 watts of radar power. A pointed white cone made of a ceramic similar to sapphire is a window which is transparent to microwave power. It passes the tube's output power to the radar's antenna while sealing the output pipe against the tube's ultra high vacuum, a pressure one-trillionth that of normal room atmosphere.

• • •

Developing the "Little" Economies (A Survey of Area Development Programs in the United States), by Donald R. Gilmore describes in detail the expenditures, employment, objectives, activities, techniques, problems foreseen, and how to deal with them, of the following types of programs or organizations:

Publicly Financed Programs—State Planning and Development Agencies, State Supported Industrial Financing Authorities, Revenue and Municipal Bonds for Financing Plants, Municipal and County Development Agencies, Local Planning Organizations, Local Redevelopment and Urban Renewal Agencies and Port Authorities.

Privately Financed Programs—Railroads, Electric and Gas Utilities, Banks, Local Chambers of Commerce, Local Industrial Development Groups, Community Development Corporations, Statewide Development Credit Corporations, Planning Industrial Parks, State Chambers of Commerce, Area Development Associations, State and Local Development Councils and Regional Development Groups.

This comprehensive study of development agencies in the United States is a supplementary paper of the Area Development Committee of the Committee for Economic Development, (CED). CED is comprised of 180 businessmen and educators whose purpose is to initiate studies into the principles of business policy and of public policy which will foster the full contribution of industry and commerce to the American economy.

Developing the "Little" Economies is available at $3.00 per copy from the Committee for Economic Development, 711 Fifth Avenue, New York 22, N. Y. Special rates for volume orders are available.

• • •

A four-part information portfolio outlining growth potential of Puerto Rico's U.S. affiliated metal working and electric product industry has been issued by the Commonwealth's Economic Development Administration.

Designed for manufacturers considering expansion, the portfolio reveals that this island industry has tripled in size every two years since 1950 and annual sales have risen 1000% to $66,000,000 since 1952. Included is a product feasibility analysis prepared by Richard L. White, former president of both the National Electrical Manufacturers Association and the American Hardware Manufacturers Association.

The portfolio can be obtained by writing to the Economic Development Administration, 666 Fifth Avenue, New York 19, N. Y., Dept. PRM.

• • •

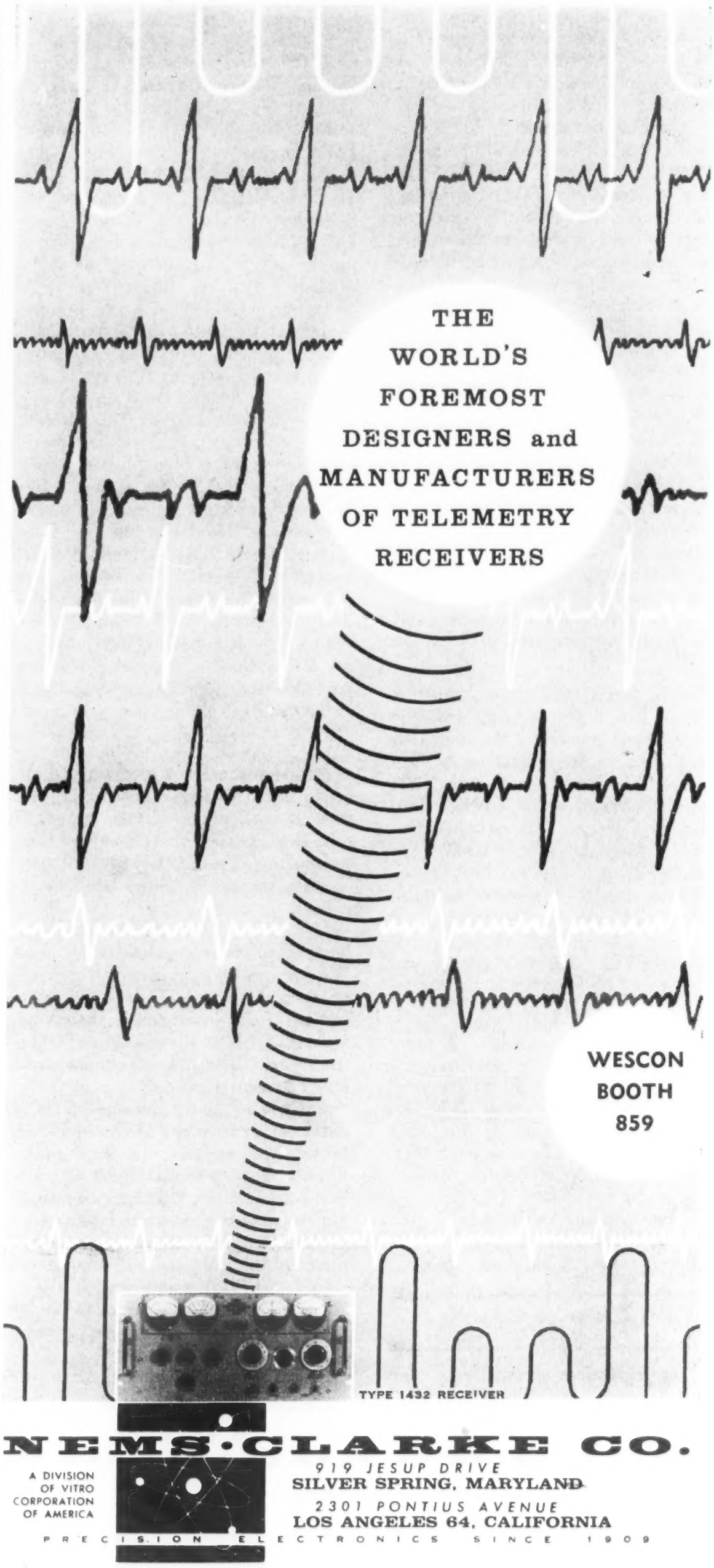
The following publications are available from the Office of Technical Services, U.S. Department of Commerce, Washington 25, D. C.

Expendable Modules as Bases for Disposal-At-Failure Maintenance, by R. O. Stone and others, the National Bureau of Standards for Bureau of Aeronautics, U.S.N., Feb. 1960. (Order No. PB 151400, $2.25 per copy.) The replacement of aviation electronics components with expendable modules is evaluated. According to the report, disposal-at-failure modules will not only help solve maintenance problems, but also are compatible with future design trends. The cost of procuring and maintaining electronic equipment designed for

expendable modules is compared with the cost of maintaining equipment containing repairable units. With the cost factor balanced out, other considerations such as reliability of equipment, smaller size, lighter weight and improved maintenance are carefully evaluated. To determine the optimum module size, modules of various electrical sizes from 1 to 12 tubes are compared from the standpoint of over-all procurement cost. The report concludes that the optimum sized module which would be the cheapest to procure and the easiest to maintain is one with 4 to 8 tubes. This estimate applies to both expendable and repairable units.

Inventions Wanted by the Armed Forces, by National Inventors Council for U.S. Department of Commerce, May 1960. This list of technical problems was prepared with the cooperation of the Army, Navy and Air Force. Each problem is one to which the armed forces are seeking a solution. The publication is a supplement to prior editions and contains 60 new problems, a number of revisions or restatements of previously published problems, and a special non-military problem. Anyone wishing a copy of problems which are still active on the 1957-59 listings may obtain a copy by writing to the National Inventors Council, U.S. Department of Commerce.

A Progress Report on Machines to Learn to Translate Languages and Retrieve Information, by R. J. Solomonoff, Zater Company for Air Research and Development Command, U.S.A.F., Oct. 1959. (Order No. PB 161263, 75c.) The report outlines the theoretical steps in developing a digital computer for mechanical language translation. The author points out that such a computer would be able to learn and "pair off" only simple, synthetic languages, and that the pairs of languages between which translation could be successfully made are very limited. Also, a skilled human translator would be needed at all times to translate what the computer could not handle, as well as rapidly answer an enormous amount of questions asked by the inquisitive machine. A further handicap is the fact that one wrong answer from the moderator would throughly confuse the machine. The report also discusses programming for a machine to retrieve information, but having similar linguistic limitations. Given a large set of documents and search indices assigned by human researchers, the



machine would learn to assign descriptors or other search indices to documents. The report describes the technical and semantic difficulties in detail, and proposes a unified method for resolving problems in both mechanical translation and information retrieval.

Army Research Task Summary 1960, by the Office of the Chief of Research and Development, USA and consisting of 6 volumes: *Medical, Biological, and Social and Behavioral Sciences*, PB 161133, $3.75; *Chemistry*, PB 161134, $3.75; *Physics* (Parts 1 & 2), PB 161135-PB 161136, $3.75 each; *Engineering*, PB 161137, $4.25; and, *Materials Technologies, Mathematics, and Operations Research*, PB 161138, $4.50. These volumes report work accomplished under the Army's Research and Development Program in Army laboratories and by contractors. Each volume contains a brief description of the purpose, scope and status of all research projects as of September 1959. Agencies, contractors and principal investigators are listed.

• • •

The essential technical characteristics of 963 different semiconductor devices now available from British manufacturers are given in tabular form in *British Semiconductor Guide*, a new publication issued by Heywood & Company, Limited, Drury house, Russell St., Drury Lane, London, W. C. 2.

The devices are presented in three main groups—transistors, diodes and rectifiers, and photosensitive devices—together with technical details and sources of supply.

• • •

Fenwal Electronics, Inc. has released a new thermistor manual, *EMC-3*. This book describes what thermistors are and what they do, gives several examples of how they are used, and tells how to solve thermistor problems. Resistance-temperature tables are included.

The manual is available upon request to Fenwal Electronics, Inc., 51 Mellen Street, Framingham, Mass.

Photoprogress

Army scientists at the Army Ordnance Corps' Picatinny Arsenal, Dover, N. J. are using a camera with an exposure speed of one five-billionth of a second to study explosive materials during detonation. Intense light required by the camera is provided by setting off an argon gas bomb simultaneously with the explosion being photographed.

In practice, blocks of explosive materials about the size of a clenched fist are detonated inside a large steel-encased cell. One end of the steel cell is open, allowing blast to escape. Portholes covered with thick shatterproof glass are located in the walls of the steel cell. The camera makes it pictures through one of these portholes. Slower cameras, including a movie camera, are mounted at other portholes to make different kinds of pictures. Scientists observe the experiments through a system of mirrors and safety windows. Detonations are set off, and cameras are operated by remote control.

In experiments so far, the camera, called a Kerr cell camera, has made still photographs of explosion shock waves traveling as fast as five miles a second (18,000 miles an hour). The camera was developed and manufactured by Electro-Optical Systems, Incorp., Pasadena, California, for and under the supervision of Picatinny scientists. The company is selling the camera commercially for use in explosives research by other government agencies and private industries.

• • •

A new automatic-processing 16mm film recorder and viewer for use with either galvanometers of a CR tube has been announced by Geotechnical Corp. of Garland, Texas. The instrument is called the Develocorder.

From 1 to 16 galvanometers can be used to record multi-channel data from DC to 20 cps, or up to 150 cps on special order. With a CR tube, DC to 15 kc data can be recorded, as well as intensity-modulated spectrograms, Lissajous patterns and other presentations.

From 4 to 32 continuous hours of data can be recorded on self-contained 200' reels of standard microfile film at speeds of 3 to 20 cm/min. Self-contained circulating chemicals and a blower process the film automatically. The Develocorder then displays the data magnified x 10 on its 6" x 17" viewscreen within 2 to 20 minutes after recording, using the 2-directional, variable-speed viewing drive.

Date, time and film number are optically printed on the film during recording. Time mark pulses are fed directly to the galvanometers. A plastic grid template can be placed over the viewscreen for data measurements. Film trace width is .05 mm. Linearity is better than 2%. Weight is 175 pounds.

Names in the News

Richard C. Stiles, supervisor of electronic switching systems design and development for Automatic Electric Laboratories, has been named to the staff of **Lt. Gen. James D. O'Connell**, USA (Ret.), vice president of General Telephone & Electronics Calif. Stiles will be concerned with long range planning for communications switching systems.

Joseph C. Myrick, vice president of Rixon Electronics, Inc., has been named to head a newly formed Research and Development Division. He is one of the company founders.

W. B. Deane was appointed director of Systems Research for International Electric Corporation, a subsidiary of International Telephone and Telegraph Corporation. Prior to his employment by IEC he was a Lt. Col. with the USAF.

C. K. Fulton has been appointed sales manager for Missile Defense Equipment in the General Electric Co., Heavy Military Electronics Department. He will direct the sales activities for the ballistic missile defense equipment being developed by the company.

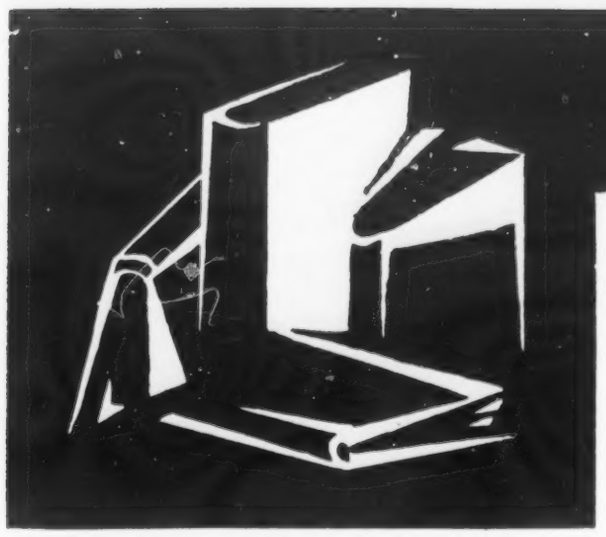
Joseph J. Gancie has been appointed to the newly created position of administrator, Defense Department Relations, American Cable & Radio Corporation. He joined the company in 1946 at New York City and for the past four years has been assigned to the Washington, D. C. office as assistant district superintendent.

Robert Crane was appointed to the newly created post of district supervisor in charge of Long Island and New York City for Burlingame Associates.

James Emmi has been named manager of the newly formed Central Overhaul and Repair Depot of Autonetics, a division of North American Aviation, Inc. He will be responsible for directing all activities of the Depot including negotiation of contracts, overhaul and repair of military products and quality control.

Samuel L. Baraf was elected president of United Transformer Corp. He was co-founder of UTC in 1933.

Col. Melvin W. Kernkamp has assumed his new duties as Chief Plans Division, Combat Developments Directorate, U. S. Army Electronic Proving Ground, Fort Huachuca, Arizona. He will be charged with the development, programming, supervision and writing of all combat Development Test Plans.



Books

COMMUNIST CHINA AND ASIA—Challenge to American Policy, by A. Doak Barnett. Harper & Brothers for the Council on Foreign Relations. N.Y.C., 1960. 575 pages, $6.95.

The emergence of Communist China as a major and dynamic power on the Asian mainland has profoundly changed the balance of political and strategic power in the world. What does the continuing growth in Communist China's strength and influence mean for the future of the free countries of Asia and for United States policy? What are the principal ways in which the Chinese Communist regime exerts its power at home and abroad? What policies can best serve American interests and those of non-Communist Asia in the next five or ten years?

These questions are dealt with comprehensively in this full-scale study of Communist China and its impact on Asia by an author who was born in China and has devoted his career ever since World War II to an investigation of China's actions and intentions. Since 1947 Mr. Barnett has spent over six years in firsthand observation, research and reporting in Asia, first in China itself and then in areas on its immediate periphery. He was in Peking in 1949 when the Communists came to power and spent seven months under their rule. Subsequently he lived for several years in Hong Kong, reporting on developments in China and traveled widely in the entire region from Japan to India.

Mr. Barnett's chapters on Communist China as a totalitarian state, on its varied policies of attraction, pressure, and subversion throughout Asia, and on its energetic programs of trade and aid offer evidence that the challenge posed to the world by Communist China operates on many different, interacting levels; ideological, political, economic and military.

The book also provides authoritative discussions on the role of the Overseas Chinese, on Peking's relations with the Communist parties in other Asian countries and on the aims and strains of the Sino-Soviet alliance. Mr. Barnett concludes with a probing examination of United States policy toward Communist China, with particular emphasis on the dangerous situation in the Taiwan Strait area, the question of the seating of mainland China in the United Nations and the present American attitudes toward diplomatic recognition of the Peking regime.

Barnett is a graduate of Yale University, a former member of the State Department and presently on the staff of the Ford Foundation.

PROPULSION SYSTEMS FOR SPACE FLIGHT, by William R. Corliss. McGraw-Hill, N.Y.C., 1960. 350 pages. $10.00.

This volume makes an up-to-date assessment of the entire field of thrust devices for use in outer space exploration. The requirements of various space missions are compared with the abilities of the different propulsion systems, and power-generating and energy-conversion theories are analyzed over a wide power range. Latest progress in ion propulsion, plasma devices, nuclear propulsion studies and chemical rocket research and development at the various industrial and government laboratories throughout the country is reported.

The book considers space propulsion from a practical viewpoint, emphasizing actual contributions and assigning them roles in the overall view of space technology. It integrates propulsion technology, sets up criteria for comparison and evaluates the entire field.

Mr. Corliss is presently on the staff of The Martin Company. He has been associated with Pratt and Whitney's Aircraft Nuclear Propulsion program and General Electric's Flight Propulsion Laboratory.

MY LIFE, by Grand Admiral Erich Raeder. U. S. Naval Institute, Annapolis, Md., 1960. 430 pages. $6.00

My Life, the autobiography of Germany's Grand Admiral Erich Raeder, is the story of a highly successful naval leader. In the World War I battles of Dogger Bank and Jutland, Raeder was Admiral von Hipper's chief of staff and tactical mentor; it was in this assignment that Raeder's mastery of naval tactics was brilliantly demonstrated. When, after the war, the Versailles Treaty stripped the German Navy of most of its combatant ships and reduced its strength to 100,000 men, Raeder patiently and methodically set about the rebuilding of his country's sea forces. Admiral Raeder was the genie of German's World War II Navy.

Raeder was not a member of the Nazi Party, but he was included in Hitler's war planning group. *My Life* contains previously unpublished accounts of what transpired at the Fuhrer's secret staff meetings before the invasions of Norway, Poland and Russia. The book also discloses new information on Operation Sea Lion, the proposed invasion of England. Admiral Raeder includes a personal account of his trial at Nurnberg, at the close of which he was sentenced to life imprisonment at Spandau. In sum, the book portrays the career of a naval officer whose devotion to duty transcended his entire life.

CONTEMPORARY THEORY IN INTERNATIONAL RELATIONS, edited by Stanley H. Hoffman. Prentice-Hall, Inc., N.Y.C., 1960. 293 pages, $4.95.

An approach to the development of doctrines capable of dealing more effectively with international problems is offered for consideration in this book.

While providing a panorama of contemporary thought on world politics, the volume shows how theories in the field can be studied and applied. It concentrates more on problems of method than on such substantive issues as the cold war or the end of colonialism. It deals with the principles, fundamental concepts and methods which should precede and govern the study, or the reshaping, of policy.

After introducing the subject on international relations as an autonomous discipline, the author discusses such significant subjects as the "realist" theory of power politics, philosophies of history and sociological derivations from social communications. He also deals with the equilibrium theory and decision making.

Mr. Hoffman's conclusion includes a detailed program of systematic, comparative historical research and a plea for the construction of "relevant utopias." He suggests a rebirth of political philosophy concerned with the definition and realization of ideals in international relations and refutes the thesis of those who condemn as hopelessly shallow attempts at applying ethical standards to the activities of nations.

Chapter News

(Continued from page 55)

yst. Convair Electronics; treasurer, Charles Hatcher, Technical Publications Department, Navy Electronics Laboratory.

Santa Barbara

A joint meeting of the chapter, the Military Order of the World Wars and the Retired Professional and Business Men's Club of Santa Barbara was held May 6, at the Mar Monte Hotel.

Lt. Cmdr. Ray E. Meyers, USN (Ret.), AFCEA regional vice president, delivered a report on the 1931 attempt of the submarine *Nautilus I* to go under the polar ice cap. He also showed a color movie of the successful expedition by the atomic-powered *Nautilus II*. The program was emceed by RAdm. Clarence C. Ray, chapter president.

Scott-St. Louis

In June, the chapter held a dinner-meeting and dance at Augustine's Restaurant, Belleville, Ill., with 101 members and guests attending.

Col. David W. Baugher, chapter president, gave a report on the 1960 AFCEA Convention. New chapter members were introduced by Allan L. Eisenmayer, chapter secretary.

Guest speaker Richard A. Fitzgerald, McDonnell Aircraft Corp., spoke on "Project Mercury — Challenge of Space." The talk was supplemented with slides.

Association Affairs

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As we go to press we have learned that the Northrop Corporation has become a group member. Company representatives will appear next month.

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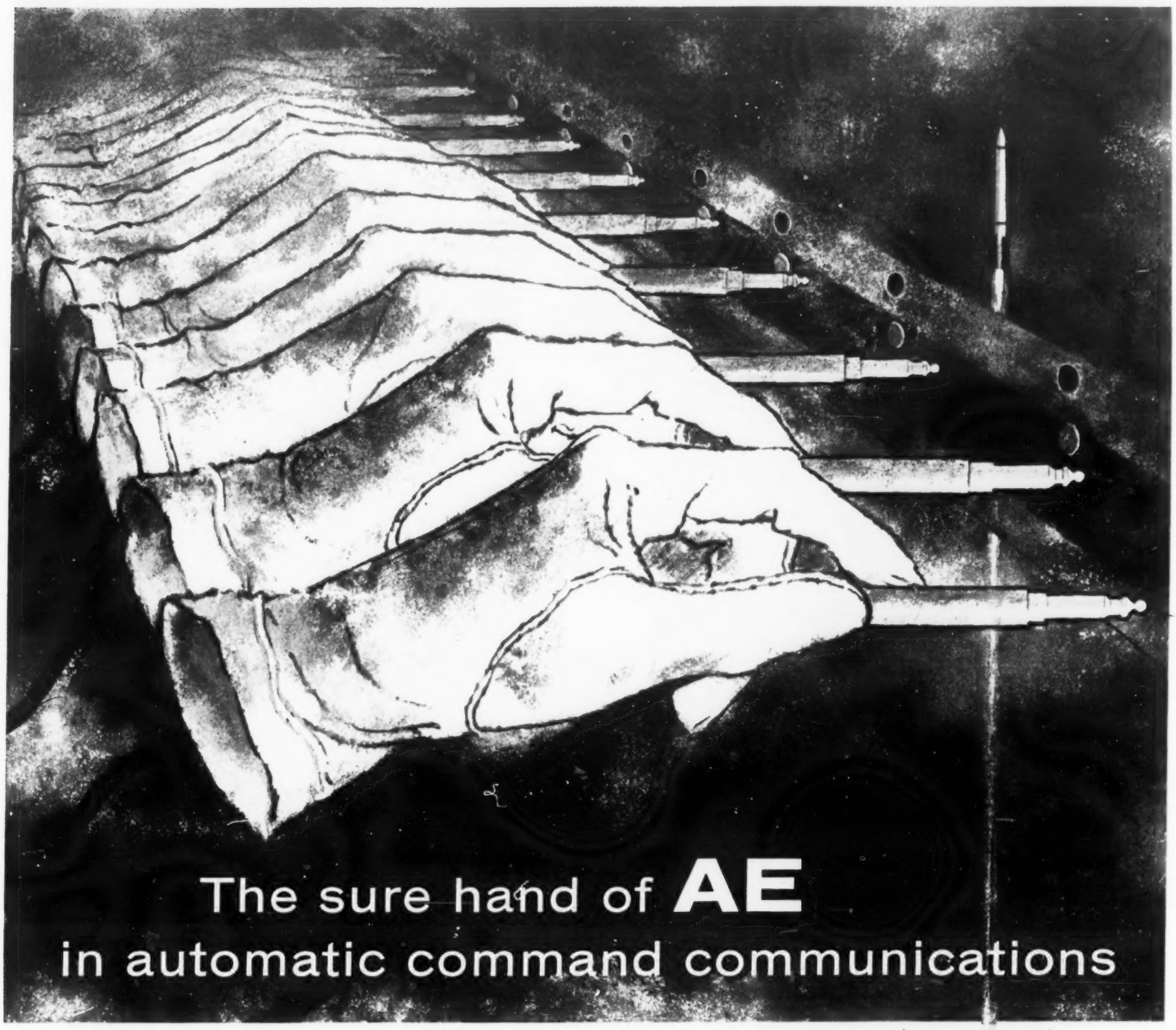

Helping "man" the missiles at the Vandenberg Air Force Base is a new 3500-line automatic telephone intercommunications network installed by AE.

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Shock — 50 g's at 4 millisec
Lightweight — 7.25 lbs
Mounting — mates to modified standard flange
Ruggedized — Ceramic and metal construction
Fixed tuned

Band	Tube Type	Frequency Range (MC)	Minimum Peak Power (KW)	Output Mates with
V	BL-235	51,000–54,000	10	UG385/U
V	BL-236	54,000–57,000	10	UG385/U
V	BL-237	57,000–60,000	10	UG385/U
V	BL-221	69,000–70,500	10	UG385/U

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